LEADING CLAY JOURNAL OF THE WORLD · A CAHNERS PUBLICATION · NOVEMBER 1961/75c

Brick & Clay RECORD

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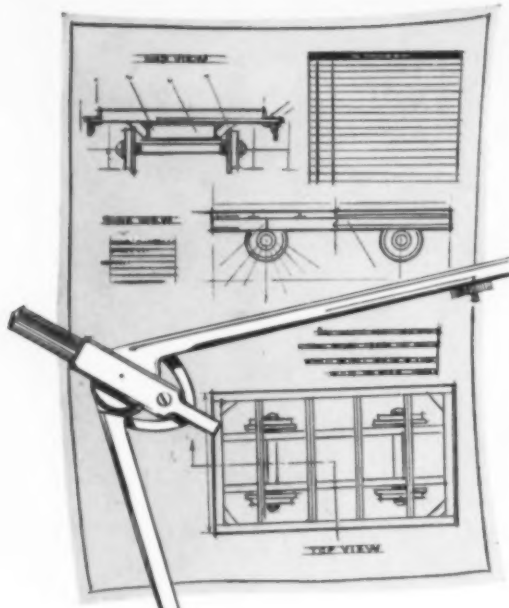
Annual clay modifiers issue



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Miller Engineering makes kiln cars. But first, Miller **engineers** them . . . precisely and exactly to your specifications, to fit your particular operation.

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Why not call or write Miller Equipment Company's Complete tunnel kiln and kiln car engineering service today? Experienced engineers will promptly analyze your needs and give you full information without obligation.

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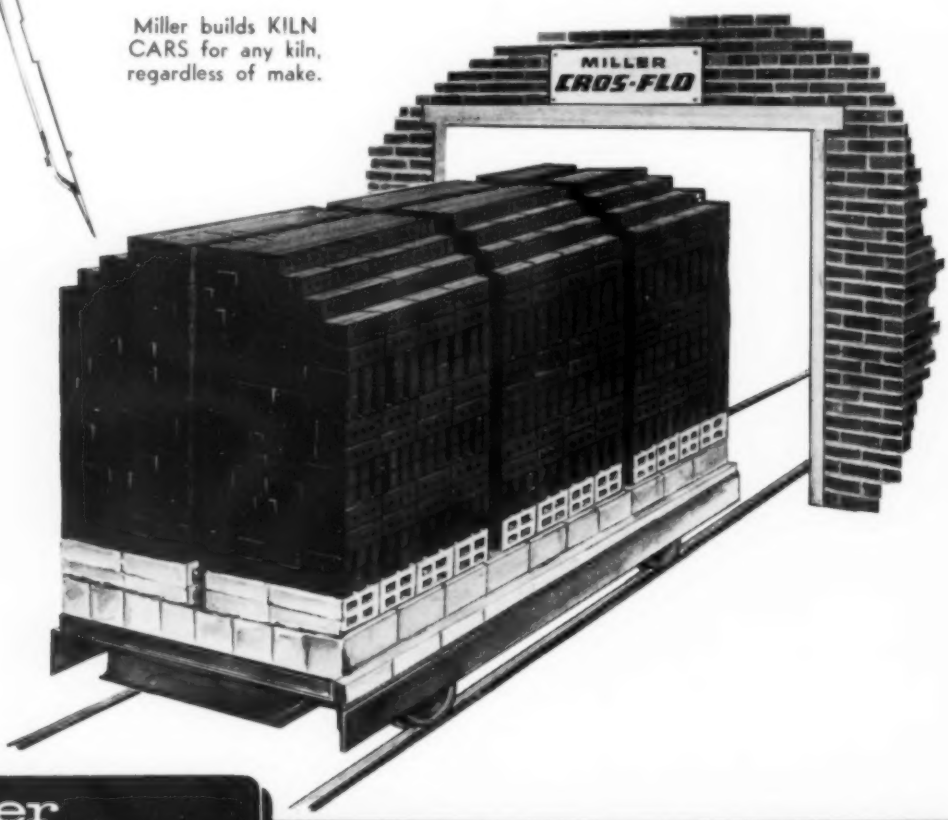

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WALTER C. STOLL & SONS
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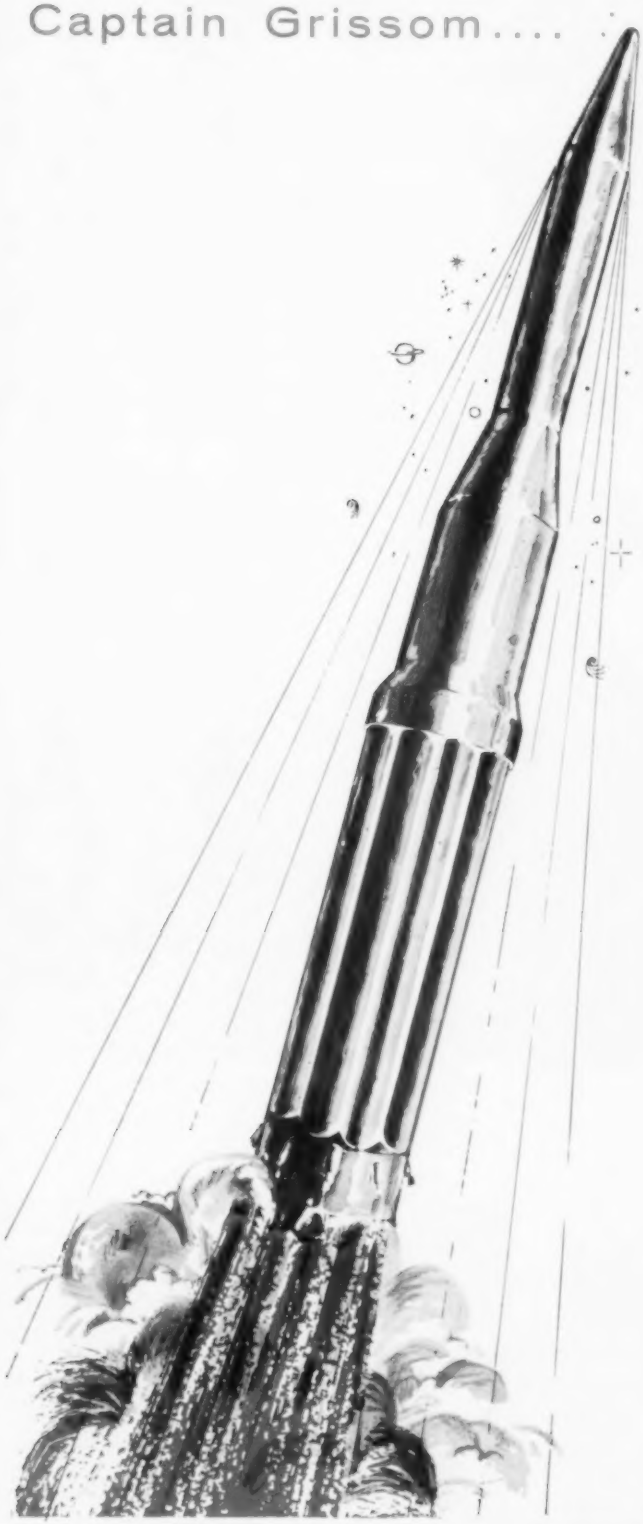
Circle Service No. 1

Commander Shepard, * Captain Grissom.... ....and now... THE SATURN



ALL launched by NASA from Pads Made of A. P. Green Refractories

Just as this country's first two astronauts were launched from heat resistant refractory concrete pads developed and installed by the A. P. Green Fire Brick Company, so, too, is the NASA Saturn scheduled to be fired from a specially designed Green refractory-surfaced pad. Company engineers have been associated with the rocket program from its early stages in the development of heat resistant refractory materials to withstand the extreme temperatures and thrust encountered in rocket blast-offs.

For over 50 years, the research, engineering and manufacturing skills of the Green Company have been providing industry with refractory products to meet advancing production requirements.

For increased production through longer refractory life in your plant, contact your nearby A. P. Green sales office or distributor. See the yellow pages of your telephone directory, or write:

Redstone Rocket such as that which successfully launched our two history-making astronauts into outer space from an A. P. Green surfaced pad at Cape Canaveral.

A. P. Green REFRACTORY PRODUCTS

A. P. GREEN FIRE BRICK COMPANY
MEXICO, MISSOURI, U. S. A.

Manufacturers of a complete line of high quality refractories including: fire clay, high alumina, semi-silica, silica, mullite, silicon carbide, zircon, and basic products.

Sales offices in the principal cities of the United States, Canada, and throughout the world.

Circle Service No. 2

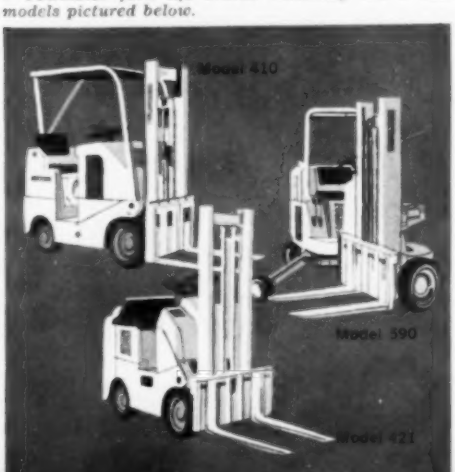
TOWMOSTATIC DRIVE

... One pedal for forward, stop and reverse

Stroboscopic photo above illustrates how toe pressure on treadle moves lift truck forward instantly—how heel pressure results in smooth reverse travel—in units equipped with Towmotor Towmostatic Drive. This foot-controlled transmission is now available on 7 Towmotor fork lift trucks including the 3 new models pictured below.

TOWMOTOR'S ON THE MOVE

—creating new uses for Towmotor Towmostatic Drive, the foot-controlled hydrostatic lift truck transmission originated by Towmotor engineers. On the move, applying this unique drive in designing unusual types of fork lift trucks that maneuver with great agility—that speed handling, utilize "lost" space, lower costs amazingly, perform many things impossible to do with conventional trucks. Keep on the move with Towmotor fork lift trucks—made only by TOWMOTOR CORPORATION, CLEVELAND 12, OHIO.



TOWMOTOR
THE ONE-MAN-GANG

Circle Service No. 3

THIS MONTH'S COVER

This is the Annual Clay Modifiers Issue of Brick & Clay Record and our cover symbolizes both the raw materials and the finished clay products. This striking illustration is used through courtesy of Columbia Southern Chemicals Magazine.

A CAHNERS PUBLICATION

Brick & Clay RECORD

Contents for November, 1961 • Vol. 139, No. 5

45 Clay Modifiers

In its annual compilation of clay modifiers, Brick & Clay Record presents a revised and up-to-date listing of materials that you can use to control firing, drying, forming, texture, color, porosity, weight, strength and size.

60 Determine Firing Schedule of Ceramic Block

It is possible to expand partially within a ceramic block during firing both the refractory and bonding phase. Cost savings can be realized by understanding and applying certain principles, but problems not common to current brickyard practices may be encountered. Another in the series by Roy B. Moffitt.

64 Glen-Gery Modernizes with Rebuilt Shale Plant

The Reading, Pa., shale plant of the Glen-Gery Shale Brick Corp. has taken on a new look. Key to the progress is a modern and efficient 372-ft. long tunnel kiln housed in an all-steel building, along with dryers and new brick forming equipment.

68 Clay Industry Favors Truck Shipping

A special study indicates that clay product plants are tending away from rail shipments and toward shipping by truck. Many of the replies to the survey indicated that losses were lower via truck than via rail. However, there is still much difference of opinion as to whether a manufacturer should own his own truck fleet or not.

70 Meeting Hears How Foam Zirconia and Alumina Are Made

A record 385 persons attended the fall meeting of the Refractories Division of the American Ceramic Society. Among the papers was a discussion of high emittance zirconia and alumina foam materials, in which it was explained how refractory zirconia and alumina base foam materials were prepared with resultant densities of 45 and 40 pounds per cubic foot, respectively.

72 Feeders Provide Uniform Blending of Raw Materials

Installation of 21 weighing type feeders minimizes shading and grading operations at kiln discharge in the Texas plant of Henderson Clay Products. More uniformity is achieved in the finished product, allowing reproducibility as a result of better raw materials control.

Departments

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Leading Clay Journal of The World
Established 1892; Now in 69th Year

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Editor and Publisher

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OHIO KILNS will do the best job for you . . .

ANOTHER OHIO KILNS INSTALLATION!

Twin Kiln Installation at Rockford Brick and Tile Co.

Ohio Tunnel Kilns are made for all types of ware, and the largest and smallest-sized production. As such, they are ideally suited for **your** plant—no matter what its size or capacity.

With Ohio Tunnel Kilns you get the most UNIFORM BURNING, the most even colors, with the least possible loss.

They cost less to install in your plant, because they are produced in volume and at minimum cost. All the materials are fabricated in our large plant, shipped to your site, and erected there by our own professional crews.

Ohio Tunnel Kilns fit your pocket-book as well as your operation. All of Ohio Kilns' exclusive features are yours at no extra cost!

NOW AVAILABLE!

The fully automatic OHIO CONTROL SYSTEM is now available for programmed control of periodic kilns. It performs equally as well as on our tunnel kilns. Present installations include round down-draft, shuttle, laboratory, and other periodics suited to programmed firing. The system is fully automatic and controls the firing from the initial light-up through peak temperature and turn down. It will faithfully follow any firing curve.

The OHIO CONTROL SYSTEM is completely assembled in our shops and shipped to you ready to place in operation. **Write for prices!**

OHIO KILNS
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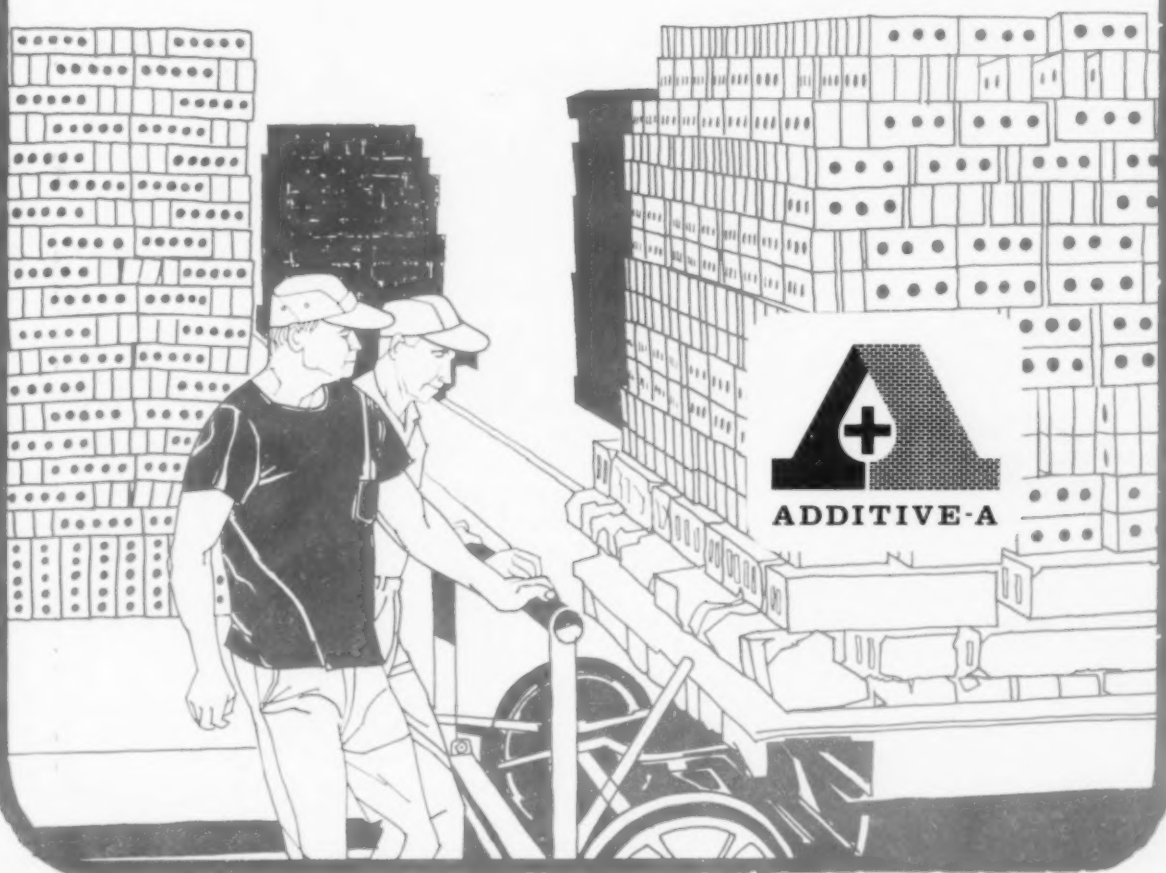
Circle Service No. 4

"ADDITIVE-A® GIVES US FINER QUALITY WARE AND IS EASY TO USE IN OUR PROCESS"

—says North Carolina brickmaker.

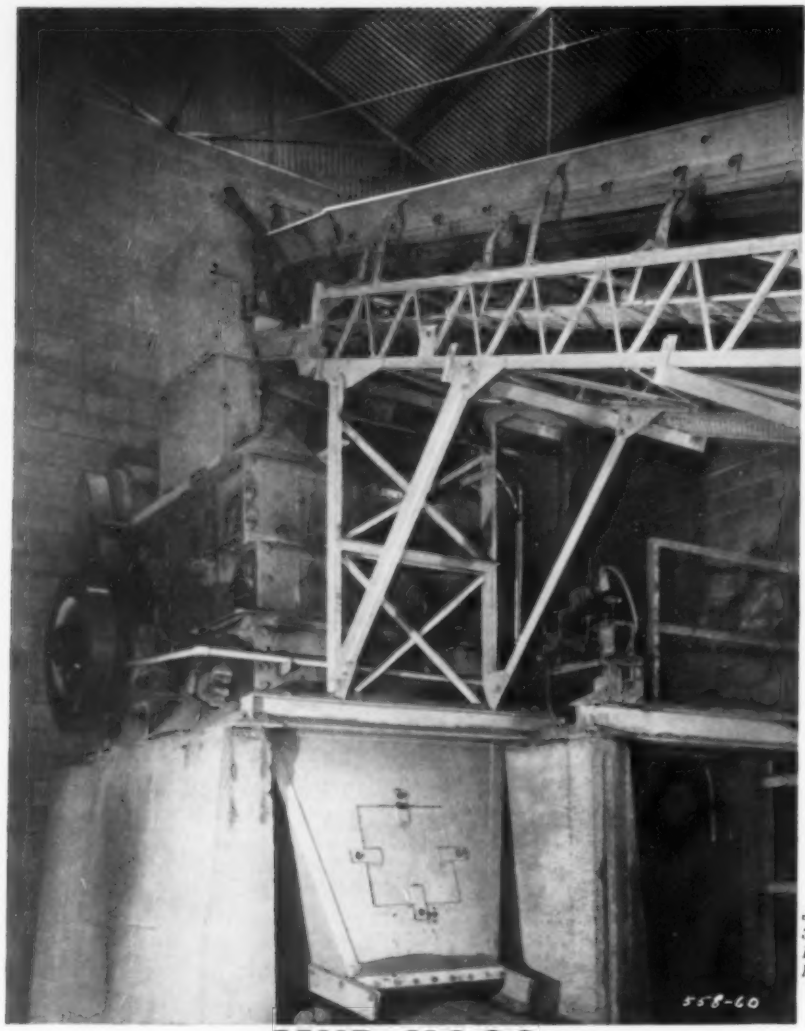
SANFORD, NORTH CAROLINA— Mr. Hugh R. Perry, general manager, Lee Brick & Tile Co., says: "We have adapted full use of Additive-A clay conditioner to all our production. It enables us to give our customers finer quality ware. We have eliminated chippage, laminations, size-and-texture variations. Additive-A has lowered our power requirements at the machine, given us greater green brick strength and decreased dryer losses. In addition, Additive-A is easy to use in our process."

For descriptive folder on Additive-A, write to:
Chemical Products, Department BCR-111,
Kimberly-Clark Corporation, Neenah, Wisconsin



Contributing Associate S C P I Kimberly-Clark

Circle Service No. 5



Jeffrey 36" x 60" Reversible Mud Hog.

MUD HOGS PROCESS WET CLAYS AT WASHINGTON BRICK

Two types of clay are blended by Washington Brick Company, Muirkirk, Maryland, in proportions to suit the bricks being made. "Sandy" clay normally has a moisture content of 10% to 15%, whereas "fat" will average 15% to 19% under good conditions, and 20% or more in rainy weather. Springs in certain areas drain into the pit, keeping clay there at maximum moisture content.

A reversible Jeffrey mud hog, set to break up sandy clay running in one direction, handles 80 tons per hour; in the opposite direction it breaks up fat clay at 40 TPH. Conveyors serving this mud hog are interlocked through an ampere-demand-control, so the feed is controlled under varying conditions of moisture.

After aging for seven to fourteen days, materials are reclaimed from storage and proportioned onto shaker screens. Oversize materials go into a second Jeffrey mud hog, to be reduced to 75% minus 4 mesh. "Our Jeffrey mud hogs are fine performers," said Mr. R. E. Rath, Superintendent of Washington Brick Company.

Jeffrey mud hogs, described in Bulletin 864-A, are designed to reduce all types of wet, sticky materials. For help on your crushing, pulverizing and screening problems, contact The Jeffrey Manufacturing Company, 916 North Fourth Street, Columbus 16, Ohio.

If it's conveyed, processed or mined, it's a job for Jeffrey. JEFFREY

Circle Service No. 6

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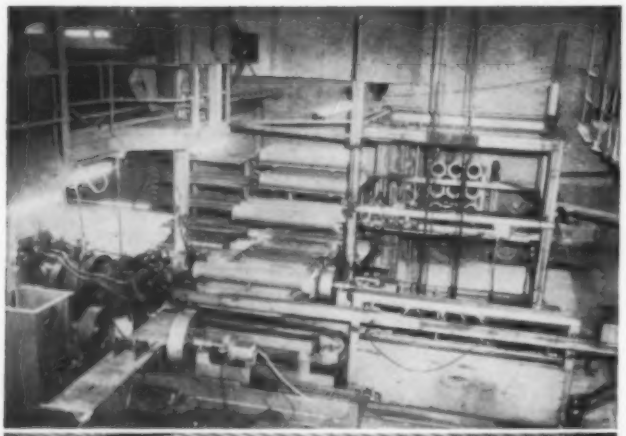
Circle Service No. 7

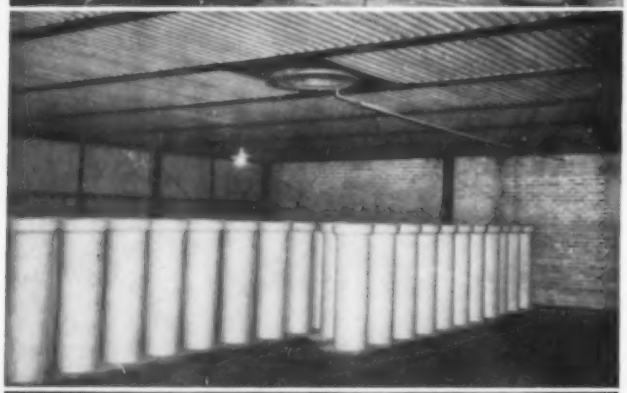
Time and cost shortcuts engineered

by HENDRYX



Pictured at the left is one of the manufacturing rooms of the Cannelton (Indiana) Sewer Pipe Company, designed by Hendryx. In sequence, beginning at the foreground are the auger machine and Pearne and Lacy equipment consisting of the former and off-bearer, the automatic finishing station and the automatic rack loader.

Hendryx designs for time, space and operating cost economy, at the same time stepping up production quality.



Ten inch sewer pipe is dried in 20 hours in this Hendryx-designed batch type dryer as compared to days or weeks in older style operations. Drying time for all pipe sizes may be anticipated at about one-sixth that of conventional practices.

For vertical drying the forced hot recirculated air flows from the steel grating floor to ports in the oven roof. The center circular vent bleeds off a controlled volume to maintain the desired humidity and permit replacement with fresh hot dry air.

Horizontal drying is faster due to freer air circulation. Four to 8″ pipe sizes are dried in 14 hours. Combination rooms afford either horizontal or vertical drying. Ports in side walls are opened and roof and floor ports are closed. Horizontal drying requires racks and rack loading equipment as seen in top picture, and P&L automatic rack unloaders can afford further savings.

Each drying room is equipped with a gas-fired, heavy duty air-heater supplying two mixing chambers and two fans. Makeup air is constantly proportioned and introduced at the mixers to maintain adequate moisture pickup capacity.

Hendryx engineering for ceramic manufacture can provide you with a complete new plant or a single installation such as drying oven and handling equipment. Hendryx developments and design are proven cost and time savers. Your inquiry for ceramic plant or facility modernization is invited.

DWIGHT B. HENDRYX AND ASSOCIATES, INC.
6621 Darlington Road
PITTSBURGH 17, PA.

Eastern representative for Pearne and Lacy Machine Co., Inc.

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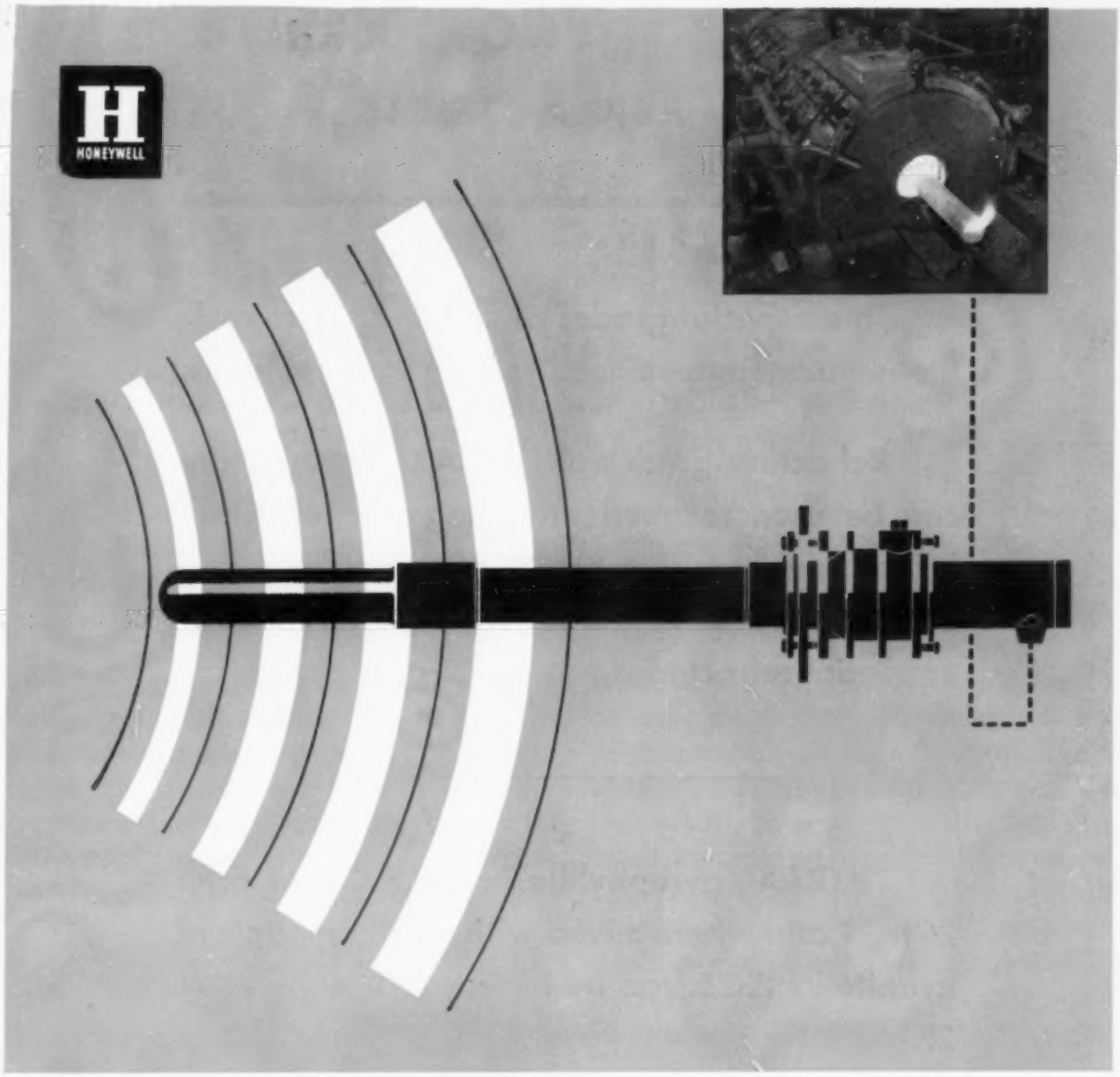

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For more than 20 years, Radiamatic Infrared Systems have been giving reliable, accurate service in every area of industrial temperature measurement and control. Over the years, Honeywell has developed special infrared techniques and equipment for a wide range of applications, including soaking pits, kilns, heat treating, induction and forging furnaces.

The key to the high accuracy and low cost of these systems is the Radiamatic Infrared Detector. Available in many different models with a full line of accessories, these detectors measure temperatures from 200°F. up to 7000°F.

For complete information on how Radiamatic Infrared Systems can solve your temperature measurement and control problems, call your nearby Honeywell field engineer. Or write Minneapolis-Honeywell, Wayne and Windrim Aves., Philadelphia 44, Pa. In Canada, Honeywell Controls, Ltd., Toronto 17, Ontario.

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HONEYWELL INTERNATIONAL Sales and Service offices in all principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

Circle Service No. 9

"PYRAX" PYROPHYLLITE

FOR REFRACTORIES

Three special grades of "PYRAX" pyrophyllite have been developed for use in refractories.

Refractory grades of "PYRAX" pyrophyllite can be used to good advantage in refractory brick, refractory cements, unfired refractories, backwalls, radiants, tile setters, saggers, and other special refractories.

"PYRAX" pyrophyllite has a P.C.E. of cone 26 to 27 and where mixed with small amounts of kyanite its P.C.E. can be increased to cone 28 or 29.

"PYRAX" pyrophyllite refractories when properly compounded have a high strength, will not spall or fail due to temperature gradient.

R. T. VANDERBILT CO., INC.
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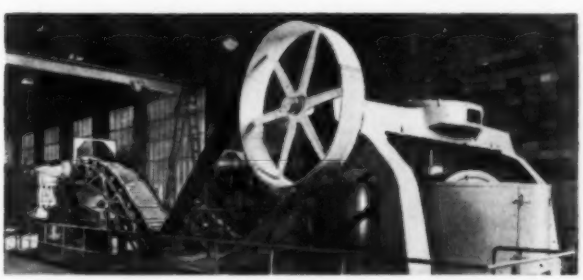
Circle Service No. 10

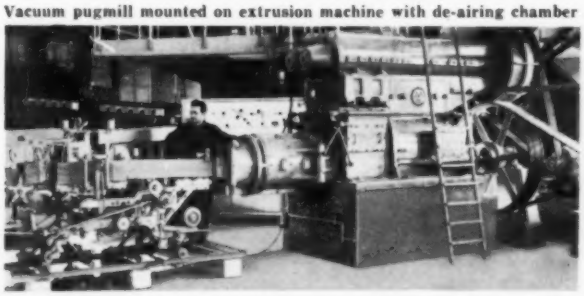
RIETERWERKE INTERNATIONAL PLANNERS & BUILDERS, DESIGN AND INSTALL COMPLETE PLANTS FOR HEAVY CLAY PRODUCTS

We have planned, designed, built and equipped brick, roofing tile, refractory clay and stoneware products plants all over the world. Our high-production machinery is precision-built to operate smoothly with clay mixes of from medium to heavy moisture content, from about 16% relative wet weight to 25%. Each piece of equipment has been integrally designed for maximum output, minimum maintenance. Machinery is protected from dirt and dust by streamlined housing wherever feasible, and is engineered for maximum noise reduction. All steel parts and castings produced under rigid quality control inspection in our own foundries.



Edgerunner with overhead drive for wet pan grinding and mixing

Vacuum pugmill mounted on extrusion machine with de-airing chamber



RIETER machinery for heavy clay products includes: Vacuum Pugmills/Extrusion Machinery/Edgerunners/Box Type Belt Feeders/Slat Conveyors/Circular Screen Feeders/Pipe Presses/Roll Crushers/Twin-Shaft Mixers/Rotary Batchers and Mixers/De-Airing Units/Piston-Type and Water-Ring Vacuum Pumps/Tempering Silos and others.

RIETERWERKE,
Dipl.-Ing. Walter Händle
Konstanz, West Germany

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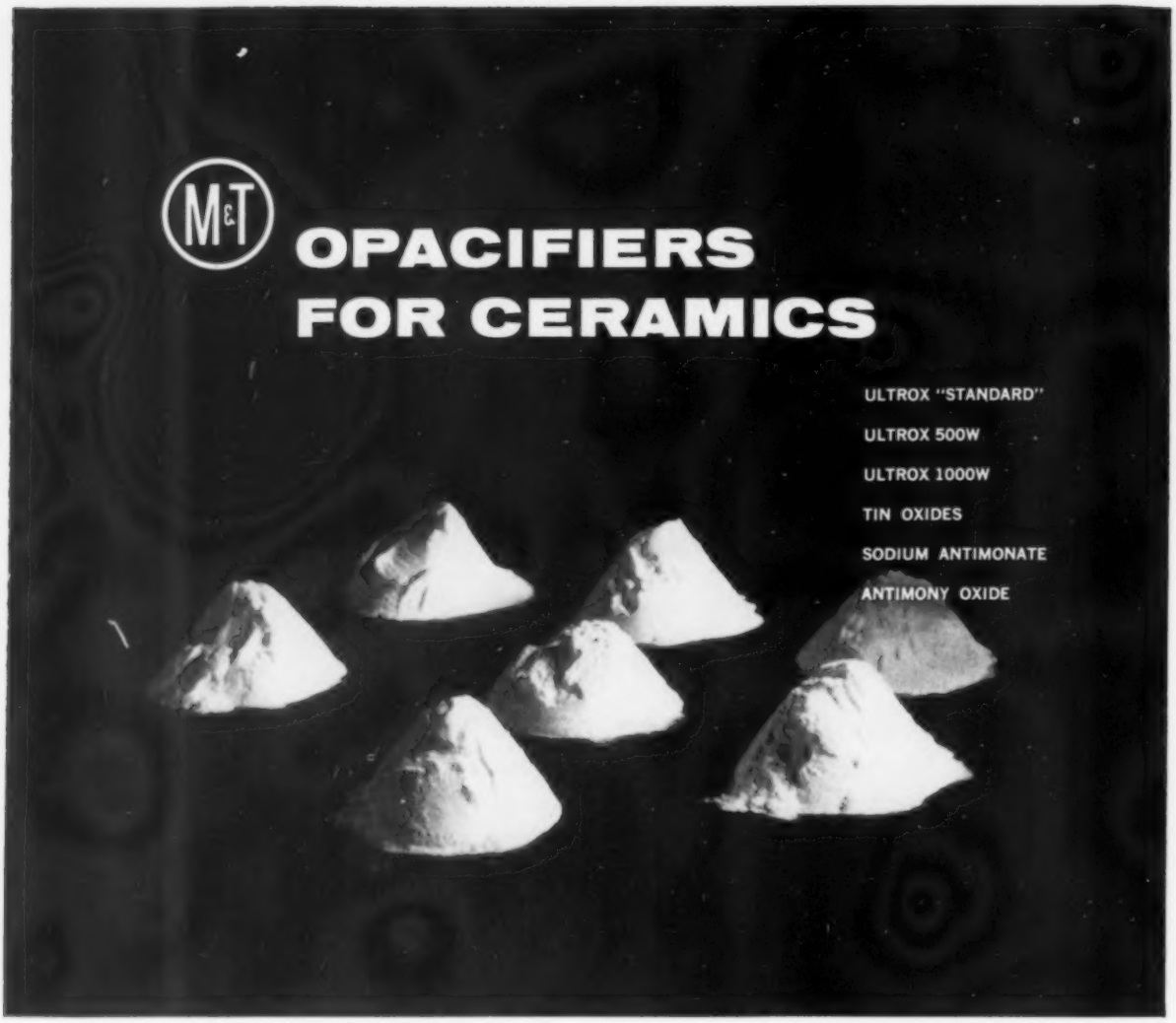


Brick and structural tile glazes improved 2 ways with ULTROX®

An unusual combination of uniformity and "latitude" is provided by ULTROX "Standard" Zirconium Opacifier because its particle size range is rigidly controlled and tailored to give excellent performance in colored glazes. Covering power is developed with maximum opacifier economy, while less stain is needed to obtain color strength. Glazes made with ULTROX "Standard" also tolerate minor variations in plant production techniques—maintaining uniform opacity and shade. This *production latitude*, another result of optimum-particle-size control, is particularly important in assuring uniform product quality in day-to-day production of glazed structural tile, glazed brick and similar ceramic products.

For strong whites or "fussy" pastels, ULTROX 500W is recommended—and, when needed, ULTROX 1000W delivers the maximum in white reflectance.

M&T Chemicals

METAL & THERMIT CORPORATION
Rahway, New Jersey
In Canada: M&T Products of Canada Ltd., Hamilton, Ont.

Circle Service No. 12

MIX-MULLER®

MEANS CONTROLLED DISPERSION

. . . AT NORTH AMERICAN REFRACTORIES COMPANY

Automation speeds processing, guards product uniformity.

No guesswork goes into the batch preparation and blending operation at North American's Curwensville, Pa., fire brick plant.

High above the press floor, two No. 3 Mix-Mullers are programmed to blend and disperse just the right amount of moisture and dry fire clay mix on a cycle carefully calculated to deliver a continuous flow of material to the presses. A central control panel permits flexibility of operation; saves time, labor and affords full and effective use of raw materials.

No guesswork went into North American's choice of mixers for this important operation either! As longtime Mix-Muller users, North American engineers selected Simpsons for their easy adaptability for automatic charge, discharge and cycling . . . as well as for Mix-Muller's proven ability to develop optimum pressing and firing characteristics for quality refractory products.

If you mix dry solids in this age of better and *more expensive* raw materials . . . can you afford to settle for *less* than *controlled* dispersion?

Dale Kephart controls dry press batch preparation and mixing operations at the Curwensville plant from National *"Time Master"* control panel.

WRITE FOR THE HANDBOOK ON MULLING.

C-101

SIMPSON *MIX-MULLER*® DIVISION National Engineering Company

654 MACHINERY HALL BLDG., CHICAGO, ILLINOIS

Circle Service No. 13

Six firms can now package 130,000 brick per day.

1. Robinson Brick & Tile Co., Denver, Colo.
2. Henderson Clay Products, Henderson, Tex.
3. Owensboro Brick & Tile Co., Owensboro, Ky.
4. Jova Brick Works, Roseton, N. Y.
5. Alton Brick Co., Maryland Heights, Mo.
6. Nebraska City Brick & Tile Co., Nebraska City, Neb.

SOON TO BE INSTALLED

Robinson Brick & Tile Co. (second machine)
Arketex Ceramics, Brazil, Ind.
Richland Shale Products Co., Winnsboro, S.C.

Acme Steel Products Division
ACME STEEL COMPANY
Dept. BCS-111, 135th St. & Perry Ave., Chicago 27, Ill.

☐ I want to see Link-Belt/Acme Steel Brick Packaging Machines in action. Contact me to arrange for viewing of your color movie.

☐ I want to talk with an Acme Idea Man about mechanizing my methods.

Name_____

Title_____

Firm_____

Address_____

City_____ Zone___ State_____

Next?

Anyone for mechanized brick packaging? Six firms are now using the Link-Belt/Acme Steel system. All have doubled to tripled former production, with lower labor costs in the bargain.

Henderson Clay Products is doing even better. They purchased their second machine over a year ago. And Robinson Brick & Tile Co. will have their No. 2 machine in operation within a few months.

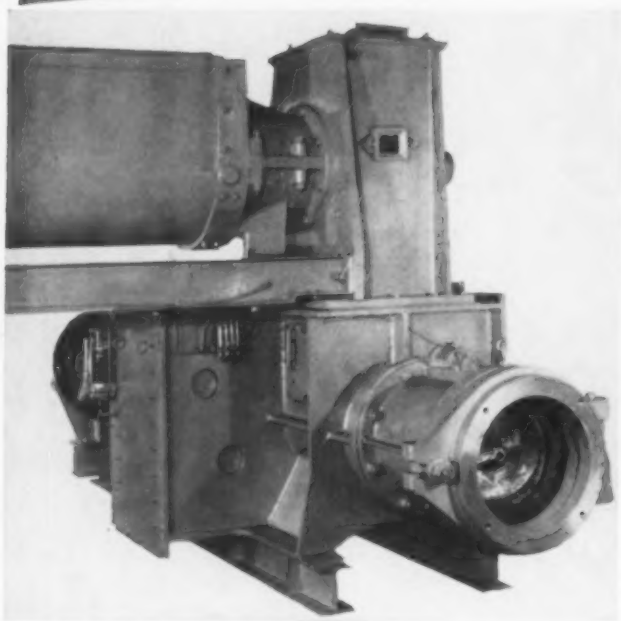
Here at last is a proved packaging method that doesn't lag behind kiln output. In seconds, brick are strapped into packs of 100, ready for loading by mechanical methods. No wonder the list is growing. Next?

ACME STEEL **IDEA LEADER IN STRAPPING**

Circle Service No. 14

CHAMBERS AUGER MACHINE

#2-11



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- 28" x 12' Pug Mill with options of 34" or twin tub pug mill suitable for vacuum pugging without added height requirements.
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- Chambers unbreakable, stress-relieved welded steel construction throughout.
- Proven efficient auger & die design. Inquire about our all-steel double-hung die holder arrangement.
- The same quality and attention to the details of design built into the Chambers #12 AC single-drive 18" Auger Machine (below) with capacities up to 300 HP.

#12 AC

Write for further details today.

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GLAZED FACING TILE

another report by FERRO

Modern technology improves products,

Producers of *glazed facing tile* have come a long way in the past fifteen years. Faced with new competitive materials, they have greatly improved their products, thoroughly modernized their manufacturing processes and facilities, set up quality checks and close color controls. The result: bigger sales than ever, with proportionate profits.

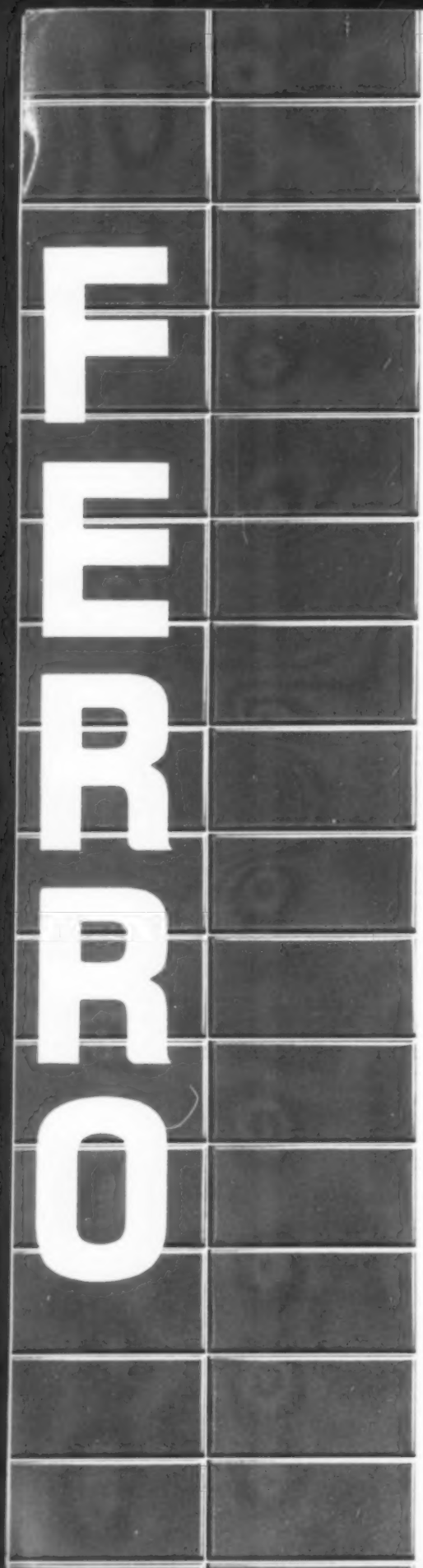
By improving the strength-to-weight ratios, they have kept pace with modern trends in building. By maintaining greater uniformity in size and colors, they have made their products more attractive to architects and builders. By providing a wider variety of finishes (matte to high gloss), greater weather-resistance (in glazes) when needed, new acoustical properties (in perforated bodies), they have substantially broadened the market for *glazed facing tile*.

Advances in technology, many of them developed by Ferro, have contributed to the progress made. Ferro's *Allied Engineering Division*, for instance, has pioneered many innovations. Basic quality has been improved through bringing about more uniform absorption. Constant improvement in tunnel kilns, and ever closer, more dependable control of temperatures throughout the firing, have also helped produce greater uniformity in colors and glaze.

production, profits

Working closely with *Allied*, Ferro's *Glaze-Color Service* has contributed new products, formulas and technical "know how" now in wide use throughout the industry. And this work continues—in helping individual customers solve specific problems, in developing still better colors, frits and techniques of benefit to *all* producers.

Few organizations in business provide a more comprehensive, yet closely integrated, service to customers than Ferro supplies to manufacturers of glazed facing tile. Together we have accomplished much. And there are still better things to come, even *now* in the development stage.



Production of GLAZED FACING TILE is our business, too!

There are many problems in the manufacture of glazed facing tile that FERRO has encountered in its 30 years of serving this industry. Finding the answers isn't always easy, but our broad knowledge and experience have helped many companies to do so. If you need help on present production—or are looking for ways and means of improving your over-all operations—you'll find it profitable to call us in. *Five divisions stand ready to serve you.*

ALLIED ENGINEERING Division
Kilns, driers, controls, engineering service
CLEVELAND 5, OHIO

COLOR Division
Stains & oxides
CLEVELAND 5, OHIO

FRIT & GLAZE Division
Glaze frits, glaze-color service
CLEVELAND 5, OHIO · NASHVILLE 11, TENN.

REFRACTORIES Division
Setters, other kiln furniture
CESCO PLANT—CROOKSVILLE, OHIO
LOUTHAN PLANT—EAST LIVERPOOL, OHIO
ACF PLANT—TYLER, TEXAS

PORCELAIN Division
Grinding balls, mill linings
EAST LIVERPOOL, OHIO

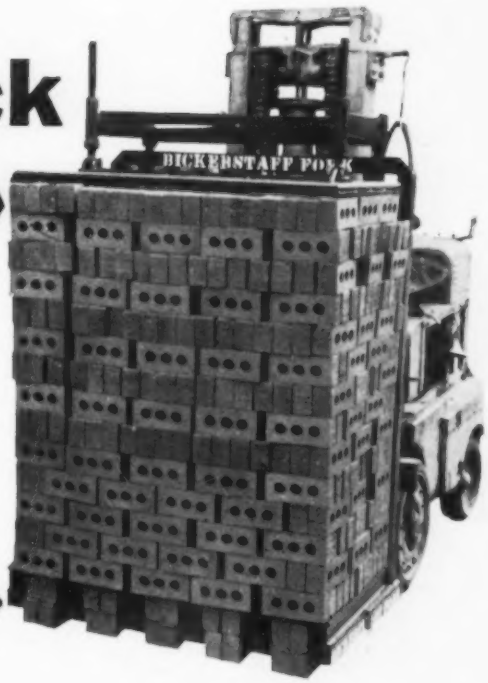
FERRO—LOS ANGELES
A complete service for the West
LOS ANGELES 39, CALIFORNIA

FERRO

FERRO CORPORATION 4150 East 56th Street, CLEVELAND 5, OHIO
In Canada: Ferro Enamels (Canada) Ltd., Oakville, Ont.

LITHO IN U.S.A.

If You SPEND MONEY to handle brick



YOU'LL SPEND LESS with Bickerstaff on the job!

A Bickerstaff Fork is a "do-it-all" when it comes to handling brick. And, it does all jobs without pallets and strapping. With a Bickerstaff Fork kilns can be set and drawn thereby increasing kiln turnover by 25%. Packages are moved from kiln to inventory and from inventory to truck or freight car quickly and easily at lower cost per load. Put Bickerstaff to work in your plant. Enjoy a smoother brick handling operation at a greater profit for you.

Bickerstaff's Complete Brick Handling Story is Yours for the asking. Write, Wire or Call.

BICKERSTAFF, inc.

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Representatives throughout the U. S. and Canada
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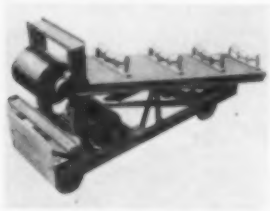
WALTER C. STOLL & SONS
5028 Alhambra Ave., Los Angeles, California

fork lift truck attachments

Circle Service No. 17

MATERIALS & EQUIPMENT IN THE NEWS

Belt Tripper



A new, heavy-duty cable-propelled belt tripper, which permits discharge of material to points along the length of a conveyor system, has been added to the line of materials handling equipment manufactured by this company.

The belt tripper, pictured, is a 5500 lb. unit with a 36" wide belt, built expressly for high capacity stockpiling operation. It is 18-ft. long, 4½-ft. wide and 7-ft. high. It is track-mounted. *Finco, Inc.*

Circle Service No. 67

Reel Stand

A new lightweight and low-cost steel strapping reel stand, specially designed for small volume users of steel strapping, has been introduced.

More economical than previous dispensers, the new Model NRE features: a conveniently located strap guide which holds strap ready for each application and an adjustable friction brake which is designed to give smooth, easy, controlled strap feed. Tension on the friction brake bushing may be varied by loosening or tightening a wing nut. *Stanley Steel Strapping, division of The Stanley Works.*

Circle Service No. 68

Pneumatic Hammer

The Branford Company introduces the *first* VIBRAJUST pneumatic sledge hammer, with manual control of impact frequency and full range of impact control. The series 7500 Model 7516 VIBRAJUST sledge hammer blows can be directed toward or away from the base mount—one or the other—or both, with each blow like the last or adjusted to suit requirements. *The Branford Co.*

Circle Service No. 69

Combination Clamp

This company has introduced a set of parts adaptable to all combination block and brick cubing clamps. The set of parts makes it possible to pick up block from the top, leaving three clear sides on cored units —two clear sides on solid. Fingers that go into cored holes are properly spaced for two and three core units. Plate nearest operator is deep enough to serve as a guide so fingers will be in line with cored holes before clamp is lowered. Adjustment is great enough to handle all cored and solid units. The clamp is designed primarily for use in cubing from a conveyor. *Besser Co.*

Circle Service No. 70

Pallet Trucks

This firm, manufacturer of material handling equipment, is introducing a complete line of

hydraulic low lift pallet trucks.

The pallet trucks feature up-to-date hydraulic component engineering with advanced manufacturing methods, precision tooling and modern high strength materials for dependable high quality at competitive prices. They are manufactured in two capacities, 2500 lbs. and 4500 lbs. and in two widths, 20½" and 27". Forks are available in three standard lengths, 36", 42", and 48". *The Prime-Mover Co.*

Circle Service No. 71

Gripper Glove

This new glass gripper glove offers an added measure of safety in handling glass, tile, lumber, concrete block and sharp dry metals.

Very flexible and long-wearing, it provides excellent grip

on dry, slick surfaces of all kinds, however, it is not recommended for use with petroleum products.

An added safety feature of this glass gripper glove is "box-tip" fingers. Curved to fit the finger, they increase both comfort and protection. *Advance Glove Mfg. Co.*

Circle Service No. 72

Cabinet Ovens

Compact, standard cabinet ovens suitable for batch production, limited production runs or experimental work requiring temperatures from 150 to 500 degrees F are now available.

These heavy duty, industrial type ovens in compact sizes are designed for use in shops, laboratories, schools, and industrial plants, and are available in four sizes, three heating capacities and for electric or gas heat. They are factory assembled and test operated. All exterior surfaces are prime painted prior to shipment. *The DeVilbiss Co.*

Circle Service No. 73

Gas Burner

A new infra-red gas burner, designated as type "K" has just been announced. Laboratory

and field installations have indicated a higher conversion ratio of fuel to infra-red than with any other commercially available infra-red gas burner. Thus, a much greater efficiency and effectiveness is possible using the new type "K" burner in drying and curing processes, heat treating metals, dry-off and bake ovens, ink drying, textiles, paper and food processing, etc. The burner is ruggedly constructed to withstand continuous industrial use. All metal parts are heat resistant alloys. Virtually flameless in operation, the burner has throttling capabilities better than 10 to 1. *Red-Ray Mfg. Co., Inc.*

Circle Service No. 74

Loaders

Recently announced is the introduction of two new four-wheel-drive, rubber-tired, front-end loaders. These are the Models H-60 with 1¾ cubic yard capacity and the Model H-70 series "C" with 2½ cubic yard

capacity buckets. (S.A.E. rated)

These new "PAYLOADER" units feature simplified bucket and boom mechanisms pioneered on the H-30 and H-120 models. Extra strong, box-section boom arms are located ahead of the operator's compartment for maximum safety. *The Frank G. Hough Co.*

Circle Service No. 75

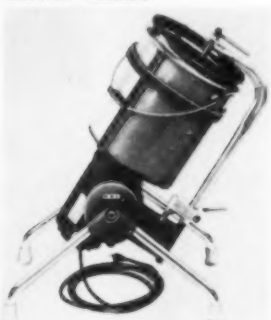
Roller Stands

This company recently announced a new series of roller stands specifically designed for ball jar milling.

Manufactured for laboratory or plant operation, the new stand features lathe cut rubber rollers with adjustable speeds, and sealed ball bearings for smooth operation and consistent milling. Available with open or sealed motor, the roller stand is made of heavy gauge steel. This new product is ideally suited for paint, atomic and chemical industries. *Ohio Kilns.*

Circle Service No. 76

Batch Mixer



This company announces the addition of a new All-Purpose Batch Mixer for industrial use to their line of portable mixers. The M-61 MIXAL is especially designed for factory, laboratory, job site, demonstration and school uses. It can mix chemicals, plastics, cements, adhesives, paints, foods, inks, epoxy, latex, concrete and tar. The MIXAL can be used for stirring, blending, folding or tumbling; and it can mix liquids, powders, granular materials, slurries, doughs and pastes.

Paddles are available that will scrape the sides and bottom of the drum for complete mixing and produce both radial and axial mixing action. The pail turns at 60 RPM to minimize air entrapment. *KOL, Inc.*

Circle Service No. 77

Gas Fork Truck

Standard power steering and full instrumentation are just two "no extra charge" features of the new 6,000-pound capacity fork lift truck developed recently.

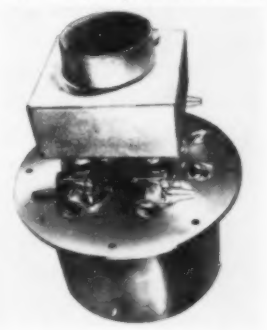
Specifically designed to meet lumber, concrete and other industries for a heavy-duty, easy to maintain truck, this new

Model FGF-060 is powered by a Continental F-244, six cylinder gasoline engine. Dual drive pneumatic tires provide solid traction and high stability. Heavy duty air filter is designed for maximum filtration in heavy dust areas. Rubber mounted trail axle requires no lubrication. Exclusive wide angle steering and standard power steering permit tight turns and exceptional maneuverability. *Baker Ind. Trucks Div., Otis Elevator Co.*

Circle Service No. 78

Tunnel Burners

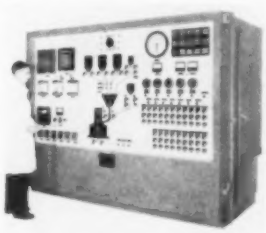
The 2004 NM and 4004 NM Multiple Tunnel Burners are high capacity burners featuring unusually short flame lengths for firing into restricted areas and/or pressurized combustion chambers. Four separate flame tunnels result in a much shorter flame length (only 2 feet) and higher heat release than can be achieved with a single burner of equal capacity. Individual flames can be controlled to provide a turndown capacity of 40/1! With 4 oz. inlet combustion-air pressure and 4 to 28 in w.c. inlet gas pressure, the 2004 NM Multiple Tunnel Burner has a range of 50,000 to 2,000,000 BTU/hr.—the 4004 NM has a range of 100,000 to 4,000,000 BTU/hr. Capacities can be increased up to 70% with higher air and gas pressures. *Pyronics, Inc.*



Circle Service No. 79

Control Panel

A new automatic control panel for weighing, mixing and batching of bulk materials makes a pushbutton operation of this common industrial process. As many as five separate



ingredients are weighed and apportioned at high speed, added to the batch at timed intervals, and the mix is also timed and controlled, all automatically by means of pre-set controls.

This panel, designed and built as a package unit, was developed for a major industrial corporation for mixing and batching of polyvinyl chloride materials. Similar units may be designed for use wherever large quantities of materials must be weighed, mixed and batched automatically at high speed. *Thayer Scale Corp.*

Circle Service No. 80

NEW LITERATURE

Pitchmaster—Complete information and data on the company's line of machinery that pitches the edges of units. The Pitchmaster will handle block or brick units 1-5/7" to full 9" high, up to 17" wide in any lengths. (Bulletin No. PM-61) *Besser Co.*

Circle Service No. 81

Mixer—A recently published brochure on the new Falcon Double Ribbon mixer includes handy reference engineering constants and short cut tables and formulas. Also includes technical data required frequently in plant operation. *Falcon Mfg. Div. First Machinery Corp.*

Circle Service No. 82

Conveyors—Recently released catalag #567 describes this company's powered flexible conveyors used to load bags and packages into box cars and trunks. It includes telescoping conveyors, multi-purpose systems, car-loading stackers, mechanical palletizers, bag flattening and elevating, sorting and mixing conveyors, etc. *Power-Curve Conveyor Co.*

Circle Service No. 83

Lubricant—Typical applications of Molykote G, a grease-type lubricant containing a high concentration of molybdenum disulfide, one of the most effective lubricants known for extreme pressure applications, are featured in a new illustrated bulletin recently published. The ability of the material to prevent galling, seizing, fretting and metal pick-up is described. *The Alpha-Molykote Corp.*

Circle Service No. 84

Duradiant Burners—Bulletin DB-2 presents a full line of "complete premix" radiant type gas units that are in successful use throughout industry. It covers design features, construction, operating principles and advantages of Duradiant burners and shows how and where the burners can best be used. Complete listing of many types available. *Selas Corp. of America.*

Circle Service No. 85

Vibratory Equipment—Details and specifications on the entire line of air cushioned vibratory finishing equipment are outlined in this new 12-page bulletin. An idea of the scope of the process is illustrated by photographs of typical parts before and after vibratory finishing. Features exclusive are described and illustrated with cut-away drawings. *Pangborn Corp.*

Circle Service No. 86

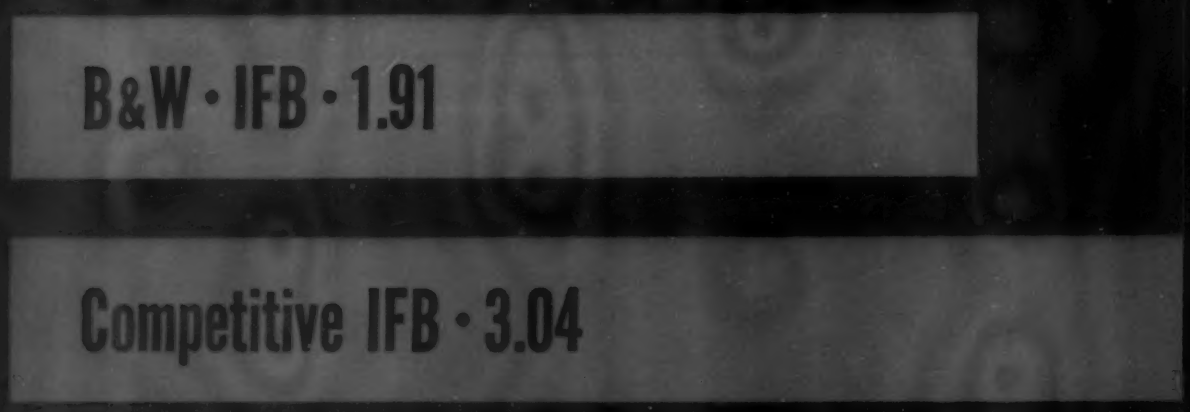
Crusher-Shredder—No. 7-AB Crusher-Shredder, a heavy duty unit with a wide range of crushing or shredding applications in operations where a minimum of fines is desired, is described in bulletin G-6. *The Bauer Bros. Co.*

Circle Service No. 87

Another *plus* of Lightweight B&W Insulating Firebrick

LOWER THERMAL CONDUCTIVITY means

THERMAL CONDUCTIVITY COEFFICIENT*



NOTE: The above chart, based on available published figures, compares the difference in thermal conductivity between lightweight B&W IFB and the average of seven other leading insulating firebrick. This example, specifically covering 2300 F use limit insulating firebrick, is representative of the low conductivity of B&W IFB at all temperature levels.

*BTU/SQ. FT./IN. THICKNESS/HR./DEG. F.

All insulating firebrick are not the same. Published figures show wide variations in *all* of the important properties among the leading brands of IFB.

Take thermal conductivity. This important property affects fuel costs, temperature control and the speed with which a furnace heats and cools. Thermal conductivities range from a B&W low of 1.91 to a high of 3.47 for a competitive IFB—*almost a 100% difference in wasted heat and fuel costs.*

You are paying for insulating firebrick . . . make sure you get *all* the benefits. B&W—the originator of IFB—manufactures a full line of IFB with an experience-proved balance of light weight, high insulating value, high strength and long life.

For complete information on B&W Insulating Firebrick, write for Catalog R-38 to The Babcock & Wilcox Company, Refractories Division, 161 East 42nd Street, New York 17, N. Y.

Circle Service No. 18

LOWER FUEL COSTS

the payoff

• 17% reduction in fuel cost • 13% increased output

Cost and operating figures, based on carefully weighed tests, have conclusively proved the superiority of B&W Insulating Firebrick to Wadsworth Brick and Tile Company, Wadsworth, Ohio. This B&W Insulating Firebrick lined kiln is providing 17% lower fuel costs and 13% increased output. This is just one of many proofs in our files that "there is an important difference in insulating firebrick."

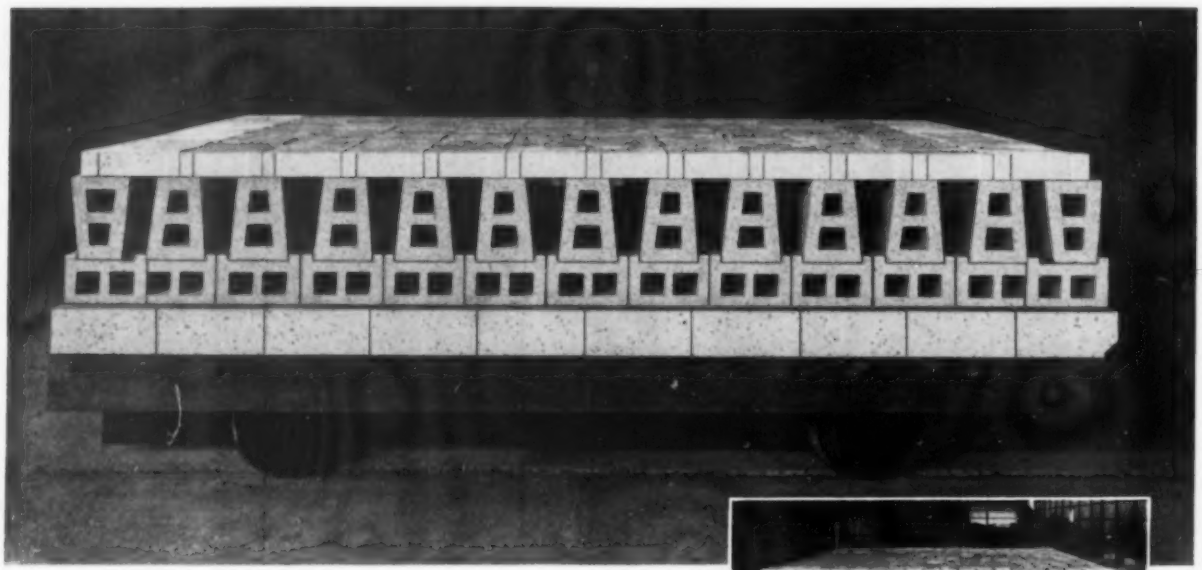
R-661

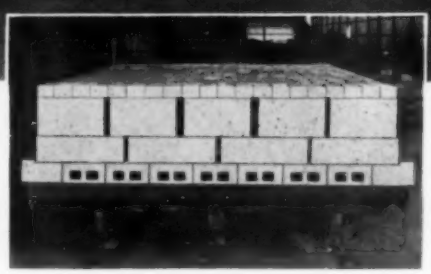
B&W

THE BABCOCK & WILCOX COMPANY

REFRACTORIES DIVISION

New Under-Fire Car Top Arrangement by PACO





...using an exclusive "A" Girder and Open Channel Block design!

Look at these outstanding PACO advantages! The "A" girder shape provides *greater stability* and offers less resistance to flame and gases. Their relatively thin wall (1⅜" max.) and open cores allow the products of combustion to freely pass through, around and between each girder and on to the entire deck surface for even distribution throughout the setting. The "bottling up" of heat in any one area is virtually eliminated. Cooling is also more uniform.

Only PACO Car Tops are made from the mineral pyrophyllite. They are stronger and highly resistant to thermal shock and hot load deformation. In addition to the under fire arrangement shown above, PACO Car Tops are made in a wide variety of shapes and sizes. Phone or write for complete information today. *You may be able to reduce your car top replacement costs by as much as 50%!*

NORTH STATE PYROPHYLLITE COMPANY, INC.

PHONE CYpress 9-1441 GREENSBORO, NORTH CAROLINA

OTHER PACO PRODUCTS INCLUDE: • Plastic Furnace Linings • High Temp. Cement • Fire Brick • Retort Cement • Blow Off Tile • Side Car Brick • Ladle Mix • Rear Arch Tile • Plastic Cupola Linings • Cupola Blocks

specifications

BOTTOM COURSE—PACO bottom block; side, corner and end blocks with center fill of castable refractory.

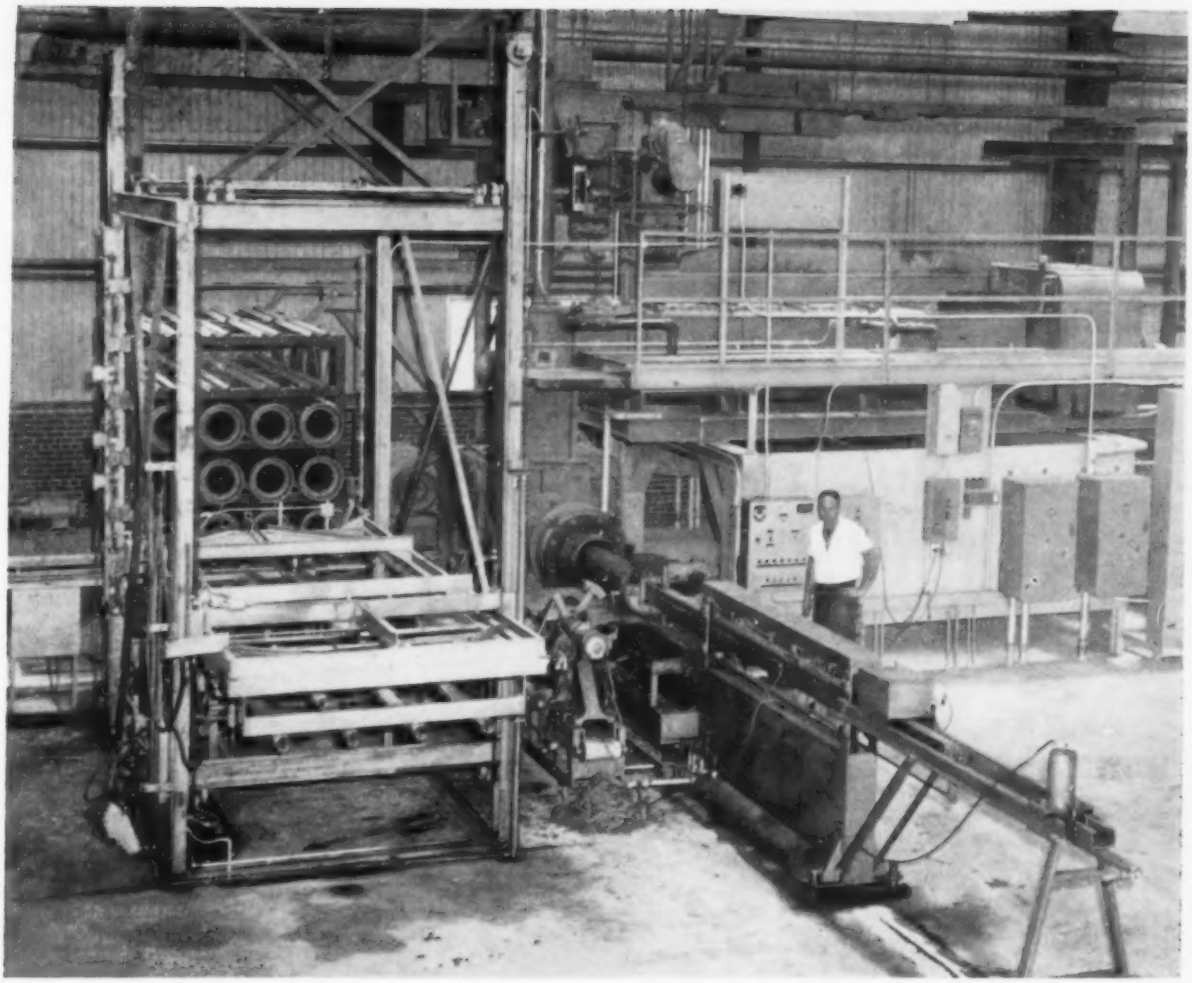
CENTER AND GIRDER COURSE—PACO channel block, designed to fit PACO "A" girder block.

TOP DECK—PACO 9" floor brick with two end courses of "A" girders, turned upside-down. The two end courses of floor brick are in a 10⅝" length to make car dimensions come out exactly right.

Open area in the deck is approx. 20%. Other PACO floor brick is available to give an open area of 30% or 40% for use with hollow ware and various other shapes requiring the larger open areas.

"A" girder block is available in heights of 7½", 9" and 11".

Circle Service No. 19



Another Complete **PEARNE and LACY** *Automatic Finishing and Handling Installation for Horizontal Drying of Clay Sewer Pipe*

This installation consists of the following units:

1. Sewer pipe die
2. Hydraulic die locker
3. Caterpillar
4. Former rod
5. Automatic finishing station
6. Rack loader
7. Control panel
8. Hydraulic pumping unit

Write for complete operation details.

Engineers and Manufacturers of Automatic Handling and Finishing Equipment for the Ceramic Industry.

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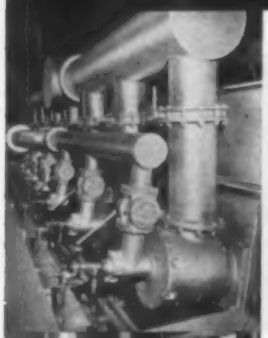
Eastern Representative
Dwight B. Hendryx, 6621 Darlington Rd., Pittsburgh, Pa.

Circle Service No. 20

PEARNE AND LACY INC. MACHINE COMPANY

CALL NORTH AMERICAN FOR

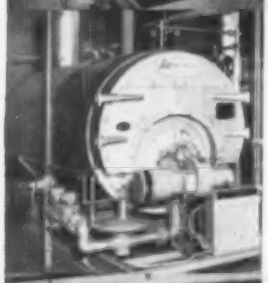


INDUSTRIAL BURNERS — 10,000 to 100,000,000 Btu per hr.

Gas, Oil, Dual-Fuel. Long, short, flat, luminous, or clear flames.

General purpose burners and burners designed for radiant tubes, immersion tubes, railroad car thawing, air heaters, kilns, forge furnaces, steel mill furnaces, incinerators.

For cold or preheated air, excess air, excess fuel.



PACKAGED AUTOMATIC BURNERS — for boilers, dryers, ovens, air or oil heaters.

Gas, Oil, Dual-Fuel. 20 to 600 boiler hp; .8 to 25 million Btu/hr.

UL, FM, and FIA approved. 100% of combustion air supplied by fan.

Packaged units with fan, valves, control cabinet, pilot, transformer, pump, and compressor.

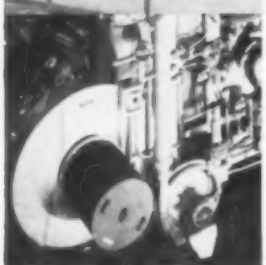
COMBUSTION CONTROLS —

Hydraulically operated pressure, flow, and fuel/air ratio controls.

Pneumatic pressure and ratio regulators. Gas-Air Mixers.

Control valves with electric, pneumatic, or hydraulic operators.

Limiting orifice valves, safety shutoff valves.



TURBO BLOWERS — 4 to 44 ounces per square inch.

60 to 14,300 cfm. ½ to 125 hp. 1800 and 3600 rpm.

Direct, V-belt, or coupled drives. 1, 2, 3, or 4 stages.

With electric motors; steam turbines; gas or diesel engines.

Variety of inlet and discharge fittings, accessories, positions.

EDGE CONTROLS — for pay-off, wind-up, intermediate process steering, belt tension, speed control.

Electric eye and air jet edge detectors.

Hydraulic edge guide regulators, power units, cylinders.

Compact and light weight. Fast, accurate, and powerful.

NORTH AMERICAN for COMBUSTION and Hydraulic Controls

The North American Mfg. Co.
Cleveland 5, Ohio

Circle Service No. 21

VERY HARD SHALE?
WET, STICKY FEED?

McLANAHAN CRUSHERS
deliver continuous, high-tonnage output for brick plant operators

Rockmaster, the world's most powerful single roll crusher, effectively reduces hardest shale and rock without difficulty . . . **Super Black Diamond,** for moderately hard materials, includes essentially all Rockmaster features. ■ About both crushers, these factors are significant: Automatic Toggles protect against uncrushable materials, with no need for stopping production . . . Improved throat opening prevents plugging by wet or sticky feeds, while allowing processing of larger size feeds . . . Quick Adjustment for changing product size without stopping the crusher. ■ A crusher manufacturer since the 1880's, McLanahan Corporation has an established reputation for very prompt service. ■ *Write for bulletins: No. RMTD on Rockmaster . . . No. SBD-95 on Super Black Diamond.*

Exclusive Ceramic Industry Representative: **THE MANUFACTURERS EQUIPMENT CO.**
218 Madeira Avenue • Dayton 4, Ohio

Pit, Mine and Quarry Equipment Since 1835

McLANAHAN *Corporation*

Hollidaysburg, Pennsylvania

Circle Service No. 22

Refractory concrete tops keep cars rolling longer

Refractory concrete car tops cast in place or precast with LUMNITE calcium-aluminate cement and aggregate will resist the soaking heat in ceramic kilns. Spalling and cracking are held to a minimum. And the low volume change of refractory concrete means tops stay level, minimizing wrecks.

Plants find that installation is easy and economical, too, since no skilled labor is required to place refractory concrete. After placing, concrete reaches service strength in 24 hours. For extra convenience, castables containing LUMNITE cement are available from leading manufacturers of refractories. These packaged mixtures are ready to use. Simply add water, mix and place.

For more information, write Universal Atlas Cement, 100 Park Avenue, New York 17, N. Y.

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Universal Atlas Cement
Division of
United States Steel

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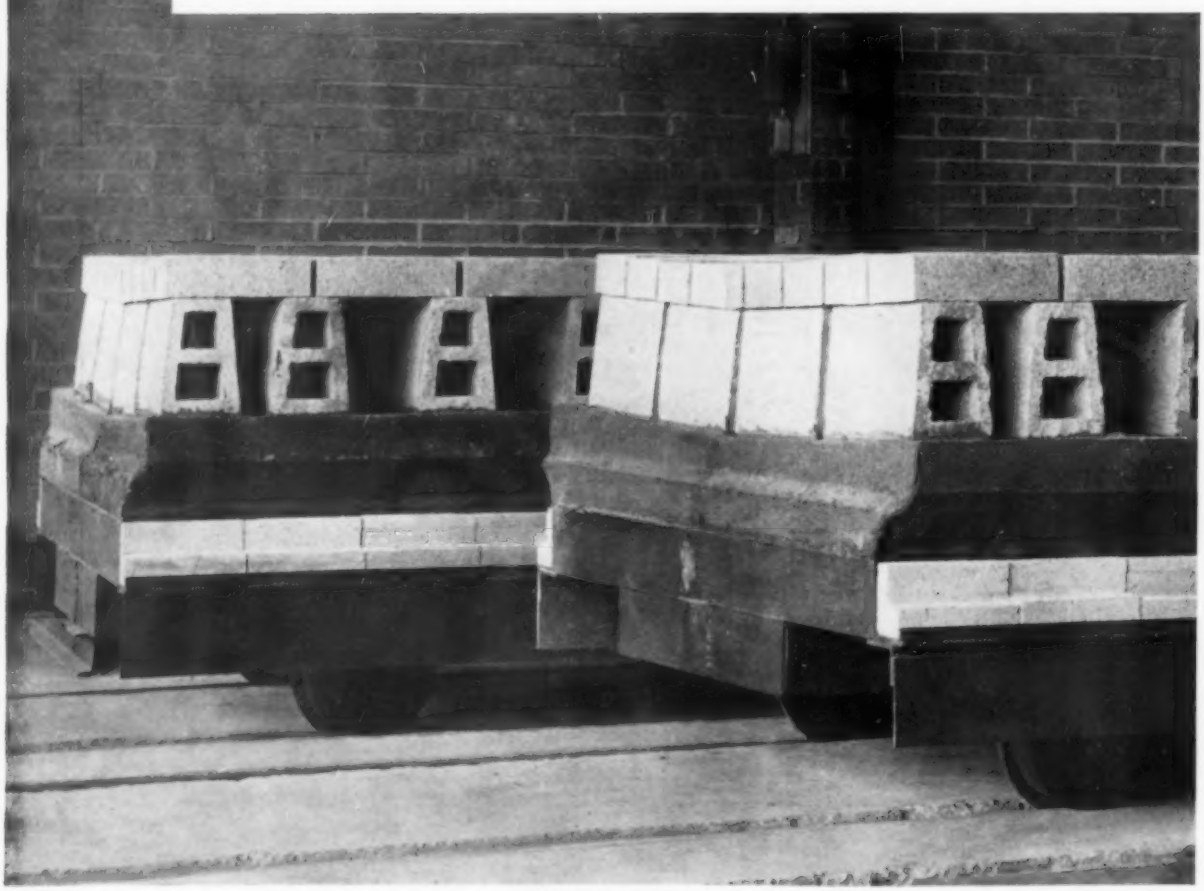


Circle Service No. 23

Editorial

It's Up To You

In this final editorial on research in the present series, we attempt to establish your part in research and ask the question, Whose research is it?

The entire research program can go ahead only as fast as you manufacturers permit it to go. Research in competitive industries is going hell bent for success, and that's just how we must go.

A savant from Columbia University recently said that the rate of research today is so great that a complete change in approach, products and management occurs every three years. Right after World War II the complete cycle of changeover was 8 to 10 years. In the 30's the complete cycle took a whole generation. We are living in a fast world and the clay products industry must keep up the pace. The rate of change we will experience in the brick and tile industry is dependent on how fast you, the manufacturer, permit it to take place.

Immediately after World War II, annual expenditures on research amounted to about $2 billion. Today research is being conducted on the basis of about $12 billion a year and before the middle of the 60's that figure will rise to $20 billion.

Are we going to participate in this rapid progress? If we do, this industry will be compelled to spend two to three times as much for research as it is spending today.

Companies competitive to the clay products industry are spending a great deal of money on research. One manufacturer who competes directly with brick and tile is spending 3% on research. Another company directly competitive with brick and tile is spending $6 million a year on research. These large expenditures for developing products that will take business away from clay should be matched as well as the industry can match them.

We all have heard considerable comment on the Structural Clay Products Research endeavors and feel somewhat let down when we really take a cold look at the remarks and at what research has done. As pointed out in previous editorials, probably 12 to 20 ideas have come out of research and only two or three have been used by the industry, and indeed only a few companies have used the ideas at all.

It is not enough to do research work and develop new products and processes. The industry must adopt them and put them into use. Every manufacturer should ask himself: How have I helped research succeed; have I used any of the products of research; have I attempted even to help prove out products that research has suggested? Probably each manufacturer asking himself these questions should assume the brunt of criticism aimed at research because he did not cooperate, he did not say, "I will make the products that have been developed through research."

We have heard the saying that in the large companies 80% of the profits this year come from products that are less than 10 years old. Can this industry say the same thing? Will it be able to say the same thing in the future? Obviously not, unless the industry adopts the products that arise from the research programs.

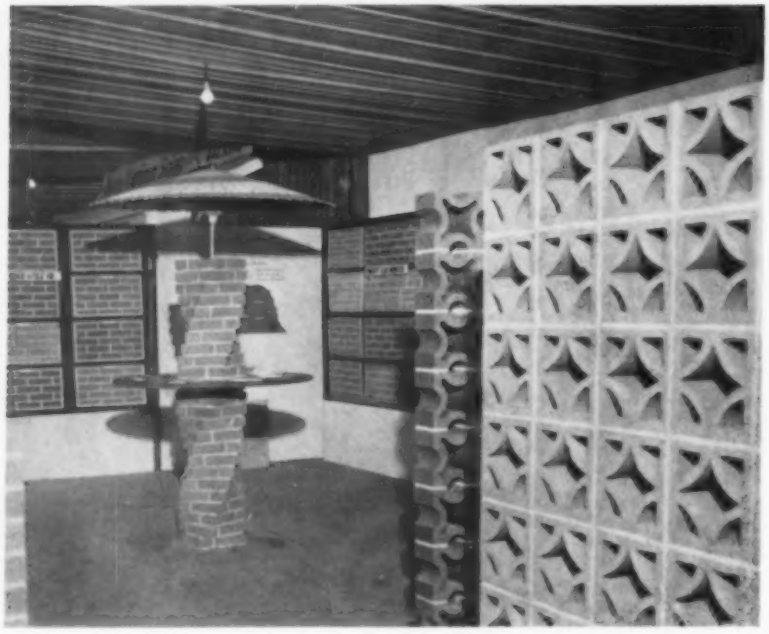
We have proved to ourselves conclusively that research has produced ideas far beyond the ability of the industry to absorb them. Research has practically paid for itself through products that have been used by the industry, in spite of the fact that only a very few manufacturers have made the products suggested. And, finally, we are convinced that if the industry adopts the products—panels, larger units, lightweight units, bricklaying systems and so on, it will not be long before clay products will stand shoulder to shoulder with the best of them and get a lion's share of the construction market because of modern products made out of the best raw material available.

J. J. Sree

Editor & Publisher

NEWS OF THE INDUSTRY

State Fair Features Brick Display



The theme of this year's booth at the Nebraska State Fair Booth was "The Wonderful Land of Clay". Instead of having an open booth as in the past years, the front of the booth was closed, utilizing both sides for colored pictures. Thus the public had to come into the booth to see the display. From a registration estimate, almost 10,000 people looked at the ideas presented in a patio, brick samples, sample wall sections and brick spiral table which is featured above.

Labor and materials were donated by the Nebraska State Conference of Bricklayers and participating brick manufacturers. Jerry Krause, SCPI representative, designed booth.

Brick Plant Strike Ends

A strike of more than four months duration at Slidell Brick & Tile Inc., Slidell, La. was unconditionally called off recently by union representatives. C. W. Schneider, president of the firm was notified of the union's decision.

Picket lines were removed from entrances to the plant where they had been maintained since contract negotations broke down last May. The plant is now running normally with a full crew of men, Schneider reported.

At full capacity, the plant uses a crew of 100 men. At the time the strike began there were about 60 employees.

Fallout? Brick Protects

Dr. John Freeman Loutit, of the United Kingdom Medical Research Council's Radiobiological Research Unit, Harwell, England at a luncheon for Chicago area nuclear writers stated in response to a question from a BRICK & CLAY RECORD editor—that he has no personal fallout shelter for his family, since he feels that the brick walls of his home in the country are sufficient protection and are preferred to the damp enclosure of a sub-surface shelter in his area where ground water levels are high.

Dr. Loutit was in Chicago to deliver three lectures in the University of Chicago sponsored Nuclear Medicine Lecture Series.

Housing Rise Predicted

Housing starts next year will rise to about 1,350,000—about 4% above this year's "slightly less than 1,300,000 units," predicted president Fred A. Manske of National Gypsum Co., Buffalo, N. Y.

He also forecast a 4% rise next year for school, heavy engineering and highway construction; an increase of about 10% for industrial building; a slight rise in store construction and a 25% increase in military building.

New Facing Tile Colors

Addition of more "Sight-Styled Colors" and new functional shapes to the line of ceramic glazed structural facing tile, is announced by Charles S. Erwin, vice president and general sales Manager of Metropolitan Brick, Inc., Canton, Ohio.

Frost White and Charcoal Grey are being produced in Satin Mat Finish. Cascade White Mottle is a further step in Metropolitan's program to meet decorative trends.

4 Million Brick Plant

The Rio Tinto Mining Co. of Australia Ltd., announced plans to build a £2 million ($5,600,000) clay brick plant at Campbellfield, near Melbourne. The new plant, represents a major diversification for the group whose interests so far have been chiefly in mining. Production is set for 50 million brick a year, and construction of the plant is to begin immediately.

Acme Brick Reorganizes

The Acme Brick Co., with headquarters in Fort Worth, Tex. is making several changes in the plants in Kansas.

A few years back Acme purchased the plants of the Great Bend Brick & Tile Co. which included plants at Great Bend and Kanopolis, Kansas.

It was announced that as a result of an overall improvement plan, the manufacturing facilities at Great Bend would be discontinued, and the company was making a move to improve product quality and service efficiency, and the Kanopolis plant would be the "hub" of operations for Acme.

However, Bill Darwin, director of marketing stated that the sales and

service yard at Great Bend will not be affected by the move, as the company plans to provide full service there including the operation of the Great Bend yard for shipments.

One of the reasons for centering on Kanopolis as the center of operations was the plentiful supply of high grade clays, which was estimated to be sufficient to meet requirements for the next 100 years.

Depletion Regulations

The Internal Revenue Service has issued regulations promulgated under H. R. 7057, which is now Public Law 87-312.

Manufacturers of structural clay products must exercise their election to take advantage of this law by December 11, 1961. The regulations set forth the procedure for exercising the election.

Those with further questions concerning this law are urged to communicate with the IRS or the Depletion Committee of the Structural Clay Products Institute.

Elected President AMC

Dee Brown, Dallas masonry contractor, was elected president of the Associated Masonry Contractors of Texas for 1962 at a recent convention in Fort Worth, Texas.

W. B. Slayden, also of Dallas, was named secretary-treasurer of the organization. Dallas has been selected as the 1962 convention site of the masonry contractors.

State Fair Display

Several uses of masonry products were exhibited at the 100th Minnesota State Fair recently. The exhibit was in the center court of the new House of Labor buildings, the most modern on the fair grounds, and on the main thoroughfare. The masonry display did much to attract persons to the area.

The exhibit sponsored by the Joint Apprenticeship Committee consisting of the Associated General Contractors of Minnesota, Mason Contractors Association, and the Minnesota State Conference of Bricklayers. Materials for the masonry display were supplied by Structural Clay Products Institute members and Anchor Block Co.

16,000 Brick Per Hour

A 40,000-pound extruder, or brick-making machine was installed in the new plant of Robinson Brick & Tile Co., Denver, Colorado, which mixes raw material and produces a continuous column of clay at the rate of 16,000 brick an hour. After being cut to size, the brick go into a warming room, a drier and then to the kilns.

The machine was manufactured by the J. C. Steele Co., Statesville, N. C. It was installed in a building 865 feet long on a 50-acre plot of land.

Brick Factory Overseas

Burma, under its second 4-year plan has authorized the government Tile and Brick Factory Board to establish a second brick plant with an annual capacity of 12 million brick. The Board would prefer a firm which is prepared to carry the construction of the entire factory on a turnkey basis.

Detailed information local clay, conditions, and requirements may be obtained from the secretary, Government Tile and Brick Factory Board, Danyingone, Insein.

Restaurant Features Sewer Pipe Wine Cellar

A highly unusual application for 4-inch sewer pipe made itself known in Denver, Colorado, recently, when the Lafitte Restaurant was completed.

In laying out plans for the $250,000 luxury eatery, owner Marvin Cook specified that the wine cellar should be on display where it would attract much attention.

The result was an 18 ft. long enclosure, enclosed in expanded metal mesh finished in black. Heavy oak framing was used to convert the expanded metal mesh into a huge "picture frame" with concealed spot lights. The 360 two-foot sections of the 4-inch pipe are formed into a neat honeycomb with cement, which extends to within a quarter inch of the lift of each horizontal pipe.

Experimental Pilot Kiln in Production

An experimental shuttle kiln, built as a pilot model to test out new design features, is being used in production with increased economy and efficiency of the thermal cycle.

The new kiln has been built by the Isenhour Brick & Tile Co., Salisbury, N. C., to simulate conditions in an existing tunnel kiln. Refractory material used in the experimental kiln, including insulating firebrick and ceramic fibers, were made by the refractories division of the Babcock & Wilcox company.

In addition to its use in producing standard structural clay products, the new kiln is also handling large structural clay shapes, such as jumbo brick, to supplement production of conventional kilns operated.

Display Fallout Shelter

A full-size clay masonry family fallout shelter has been put out on public display by the SCPI at the National Housing Center, in Washington D. C.

The brick and structural clay tile basement shelter is designed to protect a family of six against fallout radiation during the two weeks it might be necessary for the family to remain secluded in the event of nuclear attack, according to SCPI.

The eight-inch thick brick walls will provide protection against deadly radioactivity. Brick, which is made of hard-burned clay, has a natural-density which is highly suitable to fallout shelter construction. Eight inch thick structural clay tile filled with sand also offers protection from radiation. The shelter may also be built entirely of brick.

New Appointment

Thomas J. Burns, former executive with the Clay Products Association of the Southwest in Houston, Texas, was appointed executive secretary of the Virginia Brick Manufacturers Association in Richmond. He succeeds E. J. Meredith.

Ends Brick Career

R. W. Woods ended a career of more than half a century in the brick making industry when he retired as superinendent of the Athens Brick Co., Athens, Tex.

Woods' career began in 1909 carrying water for the hands at the Elgin Standard Brick Co. at Elgin, Tex.

His first position as superintendent was in 1934 with the Reliance Clay Products at Lindale. He came to Athens three years ago from the Acme Brick Co., at Baton Rouge, La.

Gladding, McBean Elects

John W. Hartley has been elected secretary-treasurer of Gladding, McBean & Co., it was announced by C. W. Planje, chairman of the board and president. He replaces Robert A. Eccles who retired after 43 years of service.

Hartley joined Gladding, McBean in 1945. With a wide background in accounting, he was previously assistant-treasurer.

Obituaries

Wesley W. Haines

Wesley W. Haines, president of the Haines Brick Corp., died recently at the age of 64. He was a charter member of the National Association of Distributors and Dealers of Structural Clay Products of Washington, D. C., and a member of the Pittsburgh Athletic Association. Survivors include his wife, six sons, and three daughters.

Marshall Lasley

Marshall Lasley, 68, former president of Southern Clay Mfg. Company, died recently. A native of Chattanooga, Mr. Lasley was born November 6, 1893, the son of William Montague Lasley and Adele Marshall Lasley. Illness forced his retirement from the business which was organized by his father.

Henry A. Finzer

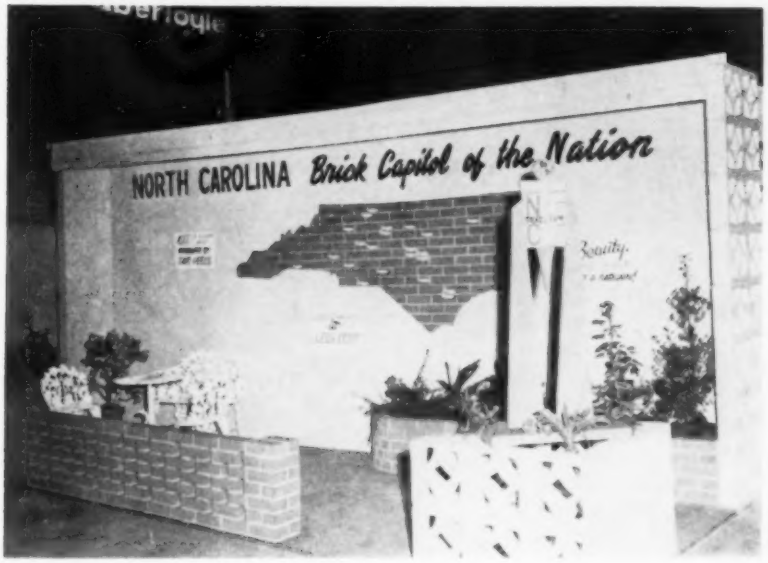
Henry A. Finzer, 80, one of the cofounders of the Finzer Bros. Clay Co. and operator of Spanish Ballroom in Dover, Ohio, died recently in his home in Sugarcreek. Survivors include five daughters and two sons. His first wife Jennie died in 1947. His second wife, Josephine, died in 1960.

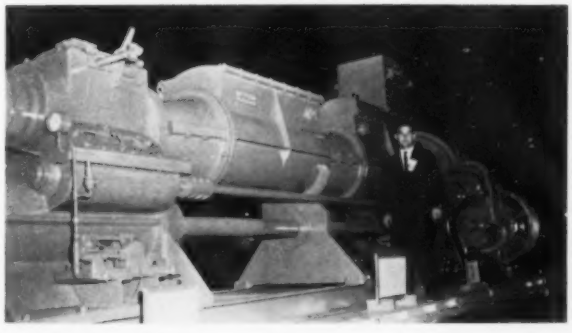
L. Guy Blackmer

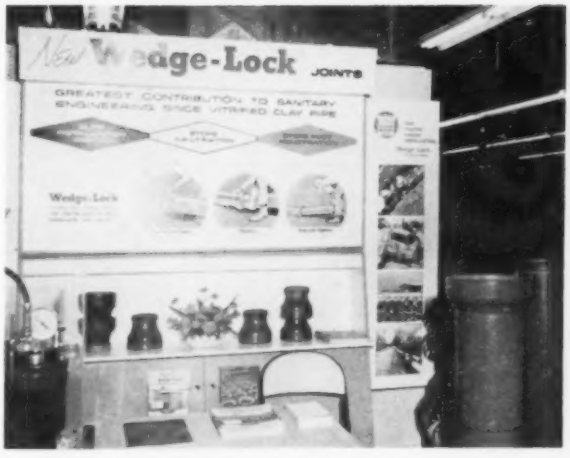
L. Guy Blackmer, 80, St. Louis, died recently in his home, after undergoing a series of operations within the past several months.

Until his retirement in 1953, Mr. Blackmer headed the old Blackmer and Post Pipe Co. which his father, Lucian Blackmer, founded in 1881. The firm which manufactured vitrified clay pipe and tile, was near the old Iron Mountain Railroad line. Surviving are his wife, and a daughter.

N. C. Industry On Display







The clay products industry was out in force at the North Carolina Trade Fair which opened in Charlotte, N. C., on Oct. 12.

The top right photo shows the 40-ft. high RBM pylons which greeted all visitors upon their arrival at the Colliseum. The pylons, only 16-in. thick at their bases were designed by Brick & Tile Service, Greensboro. Top left is the brick booth representing the entire brick industry of the state, which was sponsored by the same organization and which had a model of the pylons and illustrated all the brick manufacturing facilities in the state as well as pointing out the advantages of brick construction.

Crumpler Brick & Tile Co., Roseboro, used a pretty model to help attract attention to its booth as illustrated in the lower left photo. With Model Dee Smith are J. T. Doughtie and Mrs. A. H. Veazey, both of Crumpler.

Dick Mattox, J. C. Steele & Sons, Statesville, stands by a new Steele brick machine (right center) in the outdoor display section of the Fair. And Pomona Terra Cotta Co., Greensboro, used its booth (lower right) to illustrate the advantages of clay pipe and Wedge-Lock Joints.

Appointed Superintendent

John A. Garber was appointed general district superintendent for the Baltimore and Leslie, Maryland, and Hammond, Indiana, plants of Harbison-Walker Refractories Co., it was announced. Mr. Garber's headquarters will be in Pittsburgh.

He previously served as kiln foreman with Canadian Refractories, Ltd., a H-W subsidiary, and as kiln foreman, general foreman, assistant superintendent, and superintendent at Baltimore Works before his present appointment.

Prior to joining H-W Mr. Garber was employed by Inland Steel Co., Carnegie-Illinois Steel Corp., and Garfield Refractories Co.

Directory Available

The 1961 Product Directory of the Refractories Industry in the U.S., just published, lists 3,548 different brands of refractories for the lining of the industrial furnaces of the nation. This represents an increase of 24% over the number included in the previous directory published in 1958.

The 224 page 1961 Directory, the only single source of information on "who makes what and where" in the refractories industry, gives a company-by-company breakdown of products.

Basic Builds Plant

A new $5,000,000 special refractories plant was recently completed by Basic, Inc., Cleveland, Ohio, in connection with its magnesite production operation at Gabbs, Nevada. Refractory products for Basic's western markets, which formerly had to be shipped to the Maple Grove, Ohio plant for processing, now will be finished at the new plant.

A 6-ft. by 48-in. Hardinge conical ball mill is being used in the new plant to dry-grind refractory grain magnesia which is produced in kilns at the Gabbs plant.

Flow of magnesia clinker into the mill from the feed bin is controlled by a constant-weight feeder. The plant also uses a 90-in. by 60-ft. Ruggles-Coles XF-14 rotary dryer.

B&W Names Manager

Donald W. Devine has been named manager, personnel development, and Francis Sanfilippo, manager, wage and salary administration for the Babcock & Wilcox Company's staff division, it was announced.

Both men will provide centralized coordination, direction and assistance to all divisions and subsidiaries of the company for their respective areas and will report to E. L. Ogden, director of employee relations.

Mr. Devine joined B&W in 1959

F. Sanfilippo

D. W. Devine

as manager, personnel development, for B&W's tubular products division, and Mr. Sanfilippo was formerly wage and salary administrator for Royal McBee Corp.

Babcock & Wilcox is said to be the world's largest manufacturer of steam generating equipment, and a leading supplier of tubular products, refractories, soot blowing systems, meters and controls, electronics equipment and nuclear systems and components.

Official Retires

The retirement of H. H. Hopwood, vice president of North American Refractories Company, was announced recently. He had been with the company since 1929 and prior to that was employed by the Crescent Refractories Co.

Increases Kiln Production

Fuel and yield studies made over a five-year period by a drain tile manufacturer reveal that use of lightweight insulating firebrick in lining a periodic kiln has resulted in higher yield and lower fuel consumption.

Francesville Drain Tile Co., Francesville, Ind., is a major manufacturer of non-glazed hollow drain tile, popularly known as "Farm" drain tile. The company produces approximately 7200 tons of tile a year for customers in Indiana.

Five years ago, as part of a program to increase capacity to meet growing demand, Francesville built a steel-encased, round, down draft kiln. The new 32' I.D. kiln was completely lined with a firebrick made by the refractories division of the Babcock & Wilcox Co.

New Product Manager

The appointment of A. D. Fentzke as product manager, technical sales, was announced by the refractories division of The Babcock & Wilcox Co.

Mr. Fentzke, who joined the B&W refractories division in 1951, was formerly assistant laboratory manager of the division's technical department. He also served as staff assistant in the department as a development engineer.

Mr. Fentzke's experience with other companies includes the position of ceramic engineer with the Niles (Ohio) Firebrick Co., Union Carbide Metals Co., and research division of the Hydroelectric Power Commission for Ontario.

Named Sales Manager

Joseph A. Donovan has been named eastern district sales manager for Natco Corp., Pittsburgh, Pa.

He will be headquartered in New York City, and succeeds Joseph L. Maloney, resigned.

Mr. Donovan joined Natco as assistant eastern district sales manager in 1957. Prior to then he was chief engineer for the Clay Pipe Institute in Los Angeles, Calif.

A graduate of Villanova University, he is a member of the American Society of Civil Engineers.

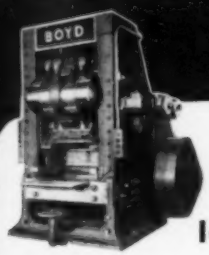
Willis F. Geib,

Willis F. Geib, retired vice president of the Mexico Refractories Co., Mexico, Mo., died suddenly while visiting in Portland, Maine. Mr. Geib was 71 years of age.

One of the founders of the Mexico Refractories Co., which in 1959 was merged into Kaiser Refractories, Mr. Geib is survived by his wife.

Circle Service No. 24 ⟶

BOYD PRESS IS BASIC / for aluminum furnace refractories



MODEL Y delivers density needed for low porosity and resistance to corrosion

More and more refractory producers are discovering how a *step-up* to a Model Y Boyd Press can be a giant step toward filling customer demands for high alumina furnace brick.

It takes a heavy duty press to deliver the power and compaction necessary to achieve a brick that will withstand the combination of destructive forces at work in an aluminum furnace.

In Model Y, a big 37″ x 21″ x 12″ mold cavity helps you make the *most* of higher pressures to increase hourly production and/or handle larger size molds. The resultant brick is extremely dense and accurate as to size—with attending properties of low porosity and resistance to corrosion.

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Aluminum holding furnace at Ravenswood Plant of Kaiser Aluminum & Chemical Corporation.

SCPRF News

The first structure to use 4-inch load-bearing exterior brick walls is now under construction at Midland, Mich. It is a 1600-sq. ft. residence in which all exterior walls and some interior load-bearing partitions are 4-inch brick laid in the new high-bond mortar. This house was originally designed for conventional brick veneer construction in which the wood studs are the load bearing elements with the brick serving merely as a non-structural veneer. The use of the high-bond mortar enables the brick wall to perform structurally, thus eliminating the need for interior wood framing. The interior finish of the 4-inch brick walls will be ½-inch gypsum board to which 1-inch Styrofoam has been bonded. This combination interior finish surface and insulation will be attached to the backside of the masonry wall with a mortar bonding technique. Dow Chemical Co. is sponsoring the construction of the house. It will be occupied by one of Dow's employes. SCPRF developed the necessary construction details for the 4-inch walls.

SCPRF is proud to welcome its newest member, the *Carlisle Brick & Tile Co.*, Carlisle, Iowa, to the industry roster of progressive clay products manufacturers supporting research. Arthur Prall's signature on the membership contract was obtained by SCPRF Chairman A. C. Frisk, president of the Goodwin Companies.

•

The strength of the new high-bond mortar developed by Dow Chemical Co. in cooperation with SCPRF increases well over 30% of its 28-day strength at the end of six months. This fact was discovered as the result of recent tests made by Dow at the end of six months and one year. For this reason, the current series of structural tests conducted at SCPRF are being made on wall specimens that are 60 to 90 days old. The usual curing period for wall specimens built with conventional mortars is 28 days, a practice that was followed in SCPRF's initial tests of high-bond walls. The current series of tests was planned to verify calculations that indicate the possibility of using an f'_m (compressive strength of masonry at age of 28 days) as high as 6000 psi in the engineering application of high-bond reinforced brick masonry. Such a working stress would make RBM more than competitive with 3000 psi concrete.

•

Paul Johnson, deputy director of SCPRF, spoke at the 28th annual meeting of the Ceramic Association of New York on October 13 at the State University College of Ceramics at Alfred University. Much of the program was devoted to research in the various branches of the ceramic industry. Pertinent comments made by the speakers included:

". . . most good ideas are actually suggestions that have been kicking around for years waiting for someone to finalize them. The time lost in putting ideas into effect sometimes means the difference between a successful year or a fair year in business."

". . . the more significant advances come from laboratories where there are some who dream."

"Three-fourths of the ideas in the ceramic industry have been stifled by management. What we need to do is be more receptive at the management level."

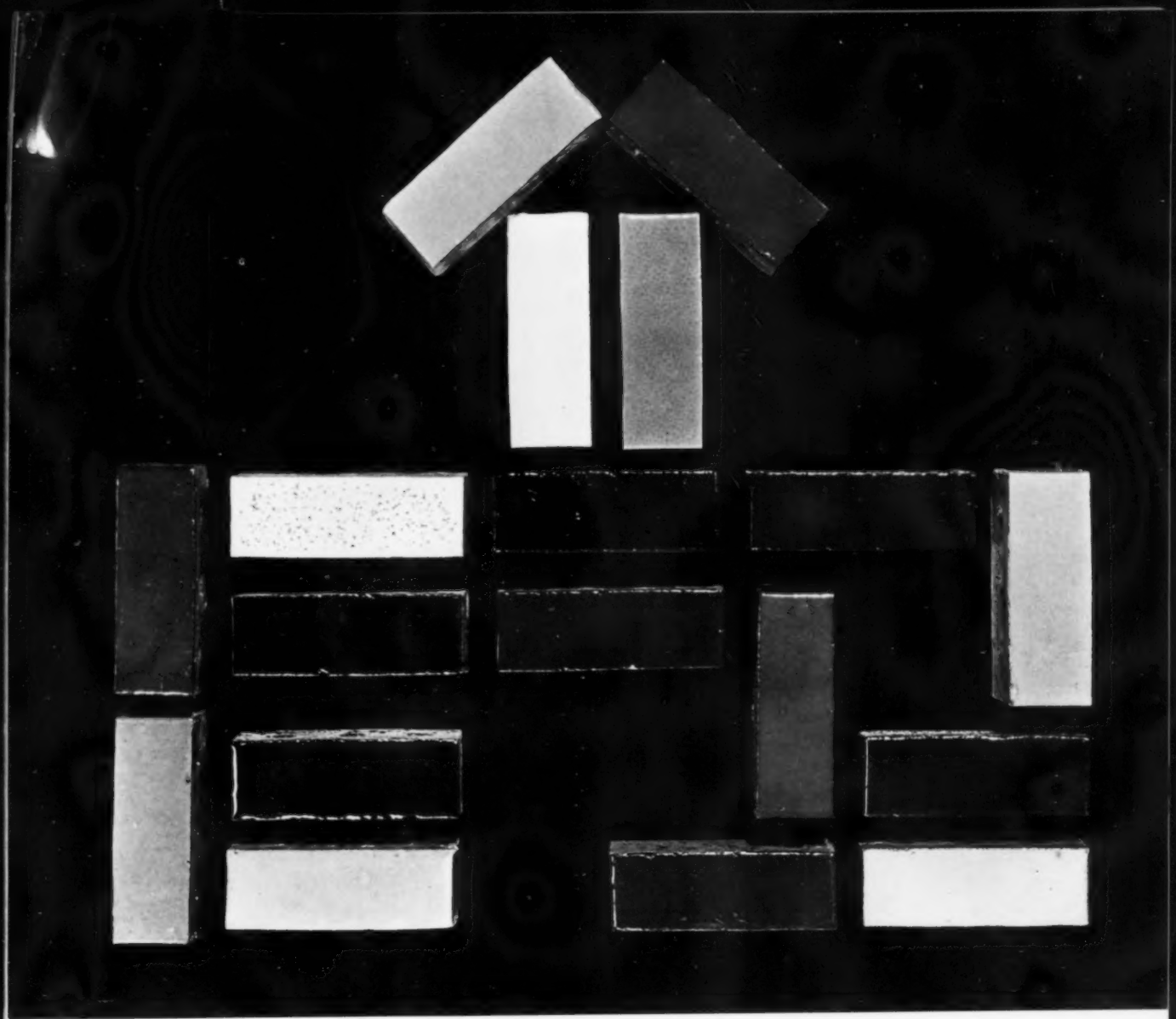
•

Construction of the "SCR verilite" production facilities for Mapleton Development, Inc., is proceeding on schedule at the Minerva, Ohio, plant of Metropolitan Brick, Inc. The tower fusion furnace and auxiliary equipment are being fabricated by Selas Corp. of American at its Philadelphia plant. The furnace and equipment is scheduled to be shipped to Minerva about the middle of November. If the present schedule is maintained, initial trial production of lightweight aggregate can be under way by the end of the year. Mapleton Development, Inc., a cooperative effort of Metropolitan Brick, Inc., and Stark Ceramics, Inc., will be the first licensed producer of the lightweight aggregate developed by SCPRF. The aggregate from this new plant will be used by the two sponsoring companies in the production of lightweight clay units in their own plants.*

Bricklayers Build Fallout Shelter

The brick industry of Denver, Colo. has built a model reinforced brick fallout shelter for display purposes at the Lakeside Shopping Center. This model was built according to the recommendations of the Civil Defense Administration to protect a small family against fallout radiation.

Circle Service No. 25 ⟶



COLOR puts a new face on brick sales

Brick coloring now goes far beyond the use of glaze stains and prepared glazes. Colors for sand blasting, colors for spraying, colored glaze specks, and engobe stains – direct results of Drakenfeld research–can also be used in almost any brick processing setup.

The popularity of today's architectural products is measured largely in COLOR. And, new decorative uses for colored brick created by architects are opening up more sales and profit opportunities. In addition, comparatively low cost per square foot continues to make brick masonry the preferred structural material.

The growing demand for colored brick can help you strengthen and expand your sales position in the market areas you serve. So, whatever your plans to produce colored brick, let Drakenfeld color ceramists help you process for profit. Get complete information. Write or phone today.

Prepared glazes pictured above

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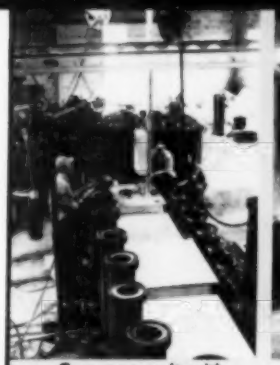
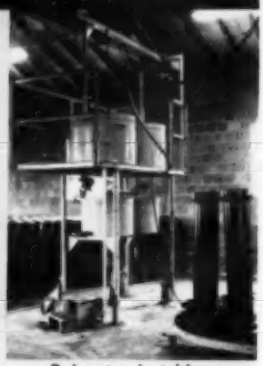
Saves manpower — easy to operate

STAR designs and manufactures a completely integrated system, adjustable to your specific needs, consisting of bridge crane, hoists, pipe clamps, conveyor unit (hydraulic indexing or mechanical continuous, with or without rotating pallets), Molds, Polyester batching systems (mixing tanks, proportioning pumps, mixing and pouring head or gun).

Write or Phone for details TODAY!

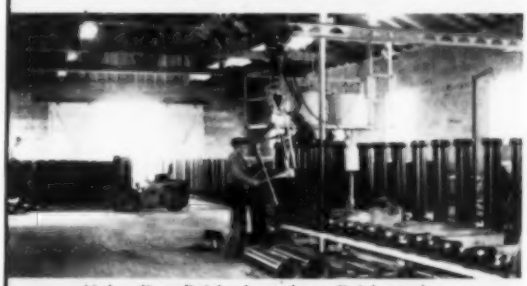


Conveyor unit with bridge crane and hoist



Polyester batching system

Mixing and pouring station



Unloading finished work at finish station

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and fire above 2000 Degrees F, B-200 Lakefield Nepheline Syenite may provide the results you seek. Our Research and Technical Service Staff will be glad to consult with you at any time to determine how B-200 will provide these benefits for your products.

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Circle Service No. 27

"Any one of our *UNIT* ¾-yd. shovels very easily loads 600 tons of clay per day from the solid", says Ralph Veon, President, RALPH A. VEON, Inc., Darlington, Pa.

7 UNITS

in eleven years for Pennsylvania Stripping Contractor

Since 1949 Mr. Veon has used UNIT shovels for contract stripping of fire clay. He now owns seven of them — five ¾-yd. machines, like the Model 1020A shown here, and two ½-yd rigs. "We find these machines very maneuverable and easy to operate," he reports. "Our cost of maintenance has been satisfactory for the past eleven years."

UNITS are easy on the pocketbook because they combine power with design simplicity. With UNIT direct in-line drive from engine to main machinery, you get ample power for heaping loads on every pass. There's no separate right angle gear reducer . . . no wasted horsepower. UNIT one-piece cast main machinery gear case design, with all gears, shafts, and bearings completely enclosed and operating in an oil bath, provides positive protection against wear . . . assures longer machine life.

All operating clutches are disc type. Engaging pressure is uniformly distributed for maximum length of service from each friction surface. Involute splined shafts are used throughout to provide greater strength and less wear. Gears, worms, turntable rollers and many other parts are drop forged to withstand greater stresses under toughest job conditions.

UNIT shovels and draglines are available in ½-, ⅝-, and ¾-yd. sizes. See your UNIT dealer soon to get complete information on the size you need.

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UNIT CRANE & SHOVEL CORP.
6649 W. Burnham Street
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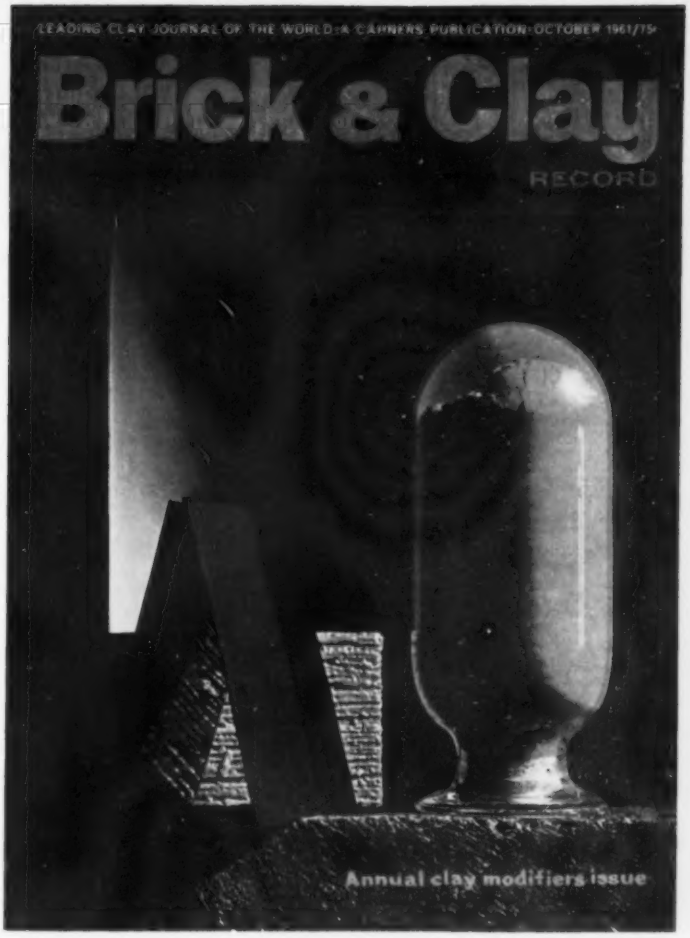
Circle Service No. 28

Clay Modifiers

Completely revised and brought up to date, the editors of B&CR have compiled a complete, concise summary of materials that you can use to control: firing, drying, forming, texture, color, porosity, weight, strength and size.



Albany Slip Clay

A low fusion point clay with a PCE of 3-5. The standard material comes from West Albany, N. Y., and gives a brown glaze. Its application in structural clay is principally for the interior glazing of sewer pipe. For such use it is slurried and applied by spraying or dipping. It has also been used as a flux and color stabilizer in quarry tile. The clay is available in lump and airfloated form.

Alumina

Al_2O_3. A material appearing in several crystalline forms, of which alpha-Al_2O_3 is the densest and most stable. Native alumina is found as the mineral corundum, having a hardness of 9.0 on the Mohs scale, and long used as an abrasive and for jewels as ruby and sapphire. The hydrated phases, gibbsite, diaspore and boehmite are also found in nature.

Although alumina occurs commonly combined as silicates in clay, feldspar, kyanite and many other minerals, the principal sources of purified alumina and hydrated alumina are native bauxites and laterites from which large tonnages are extracted annually by the Bayer process.

Bayer aluminas are available in a wide range of physical properties mainly as a result of control of crystal size and chemical reactivity during their production. Their high purity with respect to iron and fluxing impurities make them suitable for many ceramic applications in the refractory, abrasive and alumina porcelain fields.

Four types of alumina are generally considered for use in ceramic products: They are Calcined, Tabular, Fused and Hydrated aluminas.

Fused alumina is produced in large tonnages by an electrothermal process from bauxite and Bayer alumina for abrasive purposes, and although it is exceeded slightly in hardness by silicon carbide and some other synthetic abrasives, it is superior in toughness and is recommended particularly for metal grinding.

The addition of alumina to fireclays increases refractoriness, load-bearing ability and spalling resistance. A new type of high temperature insulating refractory is made from fused alumina bubbles, or hollow spheres, bonded and high fired.

This material is supplied as a castable which can be formed into the desired shape on the job and provides protection up to 3300°F. Calcined alumina and bauxite as well as tabular alumina grog are used in large tonnages to increase the alumina content of refractories. Calcined, sintered and fused aluminas constitute the base materials in a class of special refractories containing from 90 to 99% alumina, used in the form of refractory brick or monolithic liners.

Calcined alumina is added to native kyanite to adjust the alumina-silica ratio during conversion to mullite. High purity synthetic mullite is produced from alumina and low iron clay, mixed in suitable proportion to form $3Al_2O_3 \cdot 2SiO_2$ and converted by sintering or fusion. A synthetic, high-temperature, thermal insulator has been developed recently which consists substantially of mullite in the fibrous form.

Alumina is used in producing refractory calcium aluminate cements which set by hydraulic bonding. In rammed and castable compositions with refractory grogs, these cements retain good bonding strength in their effective service range. Calcium aluminate cements, prepared from Bayer alumina, may have pyrometric cone equivalents above 35.

High alumina bodies exhibit great resistance to mechanical abrasion in addition to their more widely used resistance to heat. In some formulations the service life of these materials exceeds that of hardened steel by 30-50 times.

In glazes, alumina is the means for regulating the oxygen ratio to control matteness or brilliance. The best aluminate silica ratio in conventional glaze has been found to be between 1:6 and 1:10. In glaze containing at least 0.1 equivalent of alumina, the further addition of alumina raises the deformation or maturing point. An important function of alumina is its prevention of glaze devitrification. It increases viscosity, refractoriness and opacity. In general, it increases the resistance both to chemical attack and impact resistance, tensile strength, hardness and weathering. The chief sources of alumina equivalents for glazes are feldspar and clay.

Ammonia

NH_3. This material can be used to control the pH of clays. Where the high acid condition of a naturally occurring clay is such as to cause trouble in the dryer, especially with peeling glazes, ammonia can be added to the pugging water to control the condition. Two forms are available, the anhydrous, a gas sold in drums. Ammonia Hydroxide is a liquid and is available in cans, drums or carloads. It has been found that additions of ammonia also will affect black coring and, if the problem is not too severe, will control it. Scumming is also affected when not too severe. The pH appears to be best adjusted between five and ten.

Ammonium Chloride

NH_4Cl. One of a group of materials which, by affecting the temperature of the dissociation of the sulphur compounds occurring in structural ware clays, can effectively reduce the time required to fire ware without black-coring. Due to the corrosiveness of the compound the problems connected with its use have been overcome with the addition of ammonia and ammonia bicarbonate. However, according to a patent, U.S. #2,838,410 assigned to the Spencer Chemical Co., the more effective treatments consist of application of up to .2% of a solution of Ammonium Nitrate and Ammonia or Ammonium Bicarbonate. Other combinations are said to be effective in the elimination of black coring.

Clay Modifiers

Ammonium Nitrate

NH_4NO_3. (See Ammonium Chloride)

Andalusite

$Al_2O_3 \cdot SiO_2$. The same chemical composition as sillimanite and kyanite with which andalusite forms a trimorphic series. Andalusite is orthohombic, has a specific gravity of 3-3.5 and a hardness of 7.0-7.5. Special varieties are known as Chiastolite and Viridine.

As mined for commercial use, the ore generally contains 75-85% andalusite. Minor amounts of pyrophyllite, mica, rutile and corundum are frequently present as associated minerals. The andalusite now mined in the United States comes from White Mountain in the Inyo range, Mono County, California. Deposits of commercial grade andalusite discovered to date are relatively rare, but reserves of some promise are found in Nevada, New England, Brazil, Australia, Sweden, France, Russia, Germany and Spain.

Andalusite has been used principally in spark plug porcelains and special refractories for high temperature service. The current and potential uses are limited by its availability. Along with kyanite and sillimanite it is promising as a mullite forming mineral. Andalusite, if available economically, would often be preferred for mullite type refractory bodies, since its volume stability, refractoriness, and ready conversion to mullite are desired characteristics.

Anhydrous Rasorite

An anhydrous sodium borate concentrate containing approximately 90% Na_2O, B_2O_3 and 10% of a complex insoluble clay. An addition of 6% of this material to salt used in salt glazing sewer pipe and facing materials will increase glaze thickness, reduce pinholing and crazing and generally improve the appearance of the pipe. It offers a more economical source of B_2O_3 than the refined sodium borates and can readily be substituted for either borax or anhydrous borax on an equivalent basis. (59 pounds are equivalent to 100 pounds of the hydrated borax and 111 pounds are equivalent to 100 pounds of the anhydrous borax.) The constituents contained in the insoluble clay are silica, lime, magnesia, alumina, titania and a small quantity of iron oxide.

Aplite

A fine grained rock largely composed of plagioclase feldspar, divided between albite ($Na_2O \cdot Al_2O_3 \cdot 6\ SiO_2$) and anorthite ($CaO \cdot Al_2O_3 \cdot 2\ SiO_2$) in the ratio of approximately 60% and 40%, respectively. Secondary zoisite ($4CaO \cdot 3Al_2O_3 \cdot 6\ SiO_2 \cdot H_2O$) and muscovite ($K_2O \cdot 3Al_2O_3 \cdot 6SiO_2 \cdot 2H_2O$) are associated with the basic minerals. The rock could more properly be called anorthosite or andesinite mineralogically, but the industry has widely accepted the name Aplite.

The material has a PCE of 8-9 and, in general, shares the attributes of other feldspars and nepheline syenite. Commercial production is centered in western Virginia. The grades used by the structural clay products industry are generally by-products available at low cost. Granular and fine-particle grades are sold.

Aplite is used as a molding sand in soft-mud brick, alone or in combination with other sands and coloring materials. Similarly used in stiff-mud brick in the rubbing box or by sand-blasting methods. Various desired colors are obtained in these ways. Typically gives pink effect when used alone on red brick.

The coloring principle is apparently optical, little or no fusion being experienced at typical production temperatures. The latter fact requires adherence additives, such as borax, in soft-mud brick.

In face brick and other structural products Aplite serves as a low-cost flux where operating temperatures are suitable to encourage eutectic formation. Aplite producers supply low-cost material in a variety of screen sizes permitting its use as a grog to control drying and shrinkage in low-temperature operations.

Barium Carbonate

$BaCO_3$. Insoluble in water but soluble in acids. Melts at 1,360°C. Poisonous. Occurs as the mineral witherite, which is mined in England and California. The precipitated barium carbonate used in ceramics is obtained from barytes which is reduced to soluble barium sulfide and converted to the carbonate by precipitation with soda ash.

Barium carbonate is used in glazes as a flux or to assist in the formation of a matt structure. Barium forms silicates slowly, but when barium is completely combined, it becomes almost as active a fluxing agent as lead oxide. When used in glazes in amounts greater than .1 equivalent, it renders the glaze too refractory for commercial firing.

It is used in large tonnages in the brick and sewer pipe plants to control dryer house scum and efflorescence. Dryer house scum develops when the water used in preparing the brick or pipe is evaporated in the dryer. Soluble salts, the most common of which are calcium sulfate and magnesium sulfate migrate to the exposed surfaces and are combined with the body to form complex insoluble white marks in the firing process.

Barium carbonate dosing precipitates the salts and the resulting compounds remain locked in the interior of the brick. The typical reactions are $BaCO_3 + MgSO_4 \rightarrow BaSO_4\ MgCO_3$. Other sulfates causing these difficulties are those of sodium and potassium. Brick containing free lime are subject to scumming in the kiln if sulphur bearing gases strike them when they are below the dew point of the kiln gases.

Barium carbonate can be added as a slurry or dry and should be used as early in the production line as is possible. The quantity of sulfate salts varies widely in the same pits and therefore the quantity of barium required will fluctuate widely. The most satisfactory way to determine amount needed is to make test brick from selected samples and maintain a record of barium required for material from each pit area.

Plants stockpiling raw material for later use can apply part or all of the barium requirement to stock piled material as it is laid down. In this connection it is worth noting that stockpiling can add to scumming difficulties if the clay contains appreciable amounts of pyrites, which can, under certain conditions, break down to form sulphuric acid which then combines to form soluble salts.

Each load of material dumped into the grinder can be treated with barium applied in batches or the barium can be added with a sensitive feeder continuously. It can be added to material drawn from storage while being conveyed to the pugger. Barium and water slurry can be added at the pug mill as all or part of the water added to develop plasticity.

Barytes

$BaSO_4$. A natural mineral found in Missouri, Georgia, Tennessee, California, Virginia and other states. It is the chief ore from which precipitated barium carbonate is manufactured, but may sometimes be used in the natural state. It has been demonstrated that this ore, which is reasonably pure and unadulterated, can be used as a batch constituent in glazes, although its use entails special handling problems and the batch must be fritted.

Bauxite

A non-plastic claylike material used in the production of aluminum metal and aluminum oxide for the ceramic field and the chemical industry. It is used by itself as an addition to abrasives, refractories, cements and other ceramics.

The amounts of silica, iron and water present in bauxites control the value for use in refractories, abrasives and in cements. For refractory purposes a calcined bauxite of high alumina content, controlled low iron and low loss on ignition is required. It is an excellent material for refractory brick, provided adequate attention is given to initial calcining to take care of the tendency of bauxite with residual moisture to shrink at the temperatures at which the refractories are used. Bauxite refractories have adequate strength when cold and at working temperatures. They resist cracking, spalling and chemical and physical reaction with the furnace charges with which they come into contact.

Mullite refractories are produced from mixtures of bauxite and silica sand or quartz by the sinter-bonded method or by the electrically fused-cast method, in which case the starting material is alumina derived from bauxite.

The chief uses of bauxite refractories are: For linings in rotary kilns for the manufacture of portland cement, dolomite and lime; for lining in combustion chambers of boiler installations for use in ceramic industries, e.g. glass tank blocks, furnace parts, regenerator wall construction and in checkers; in the metals industry for center walls of zinc distillation furnaces, bottoms of malleable iron furnaces, water cooled parts of basic open hearth furnaces and in all types of furnaces where the ash has a high corrosive effect on brick.

In recent years bauxite has been used in increasing quantities for the manufacture of special quick hardening high alumina cements. These cements are prepared in blast furnaces, rotary kilns or electric furnaces by the fusion of bauxite and limestone. The resulting product consists of a mixture of calcium aluminates and calcium aluminum silicates with some iron oxide and possibly some calcium silicates.

Bauxite abrasives are prepared by fusion of a mixture of calcined bauxite, coke and iron turnings in an arc type electric furnace at temperatures above 2,000°F. Massive corundum crystals containing 94-95% aluminum oxide result. These are crushed, ground and separated into various grit or grain sizes which are then manufactured into abrasive products such as grinding wheels, abrasive stones, abrasive cloths and papers and grinding and polishing powders. Fused alumina grinding wheels are made of the material and used extensively in the metals industries in grinding and polishing.

Bentonite

A natural clay-like substance. A hydrous silicate of alumina. Derived from volcanic ash, with the clay mineral, montmorillonite ($Al_2O_3 \cdot 4SiO_2 \cdot 9H_2O$) as the chief constituent. The name of bentonite originally applied only to a specific type that occurs in the Fort Benton formation in the Black Hills of Wyoming and South Dakota. Later all clays comprising chiefly montmorillonite and derived from volcanic ash were classed as bentonites. For practical purposes it is necessary to subdivide bentonite into two types: (1) Those that swell enormously when wetted, and (2) those that swell no more than other plastic clays. Type 2 is widely used as a clarifying clay, as a carrier and sticking agent for insecticides, and for improving plasticity and workability in ware where color is not important, such as sewer pipe.

From 1% to 3% of bentonite is used successfully in high temperature cements, mortars and various plastic refractories. Bentonite is also used in structural ware to insure sharp edges, high green, dry and fired strengths. As low as ¼% of bentonite prevents glazes from settling; high film strengths are obtained.

Beryl

$3BeO{:}Al_2O_3{:}6SiO_2$. It is the ore from which Beryllium oxide is recovered by treatment of the ore with sodium silico-fluoride at 850°C. The resulting sodium fluorberyllate is dissolved in boiling water, filtered and the oxide precipitated with caustic. At present it is the only commercial source and consequently of prime importance.

To one interested in colored glazes, beryl offers an unusual property, the ability to produce high-temperature chrome greens.

Beryllium Oxide

(BeO)Beryllia. Melting point 2510°C. Specific gravity 3.0. This material, with very high thermal conductivity, good heat stock resistance and a hardness of 9 on the Mohs scale has been used for the production of very high temperature melting crucibles.

Bodies can be formed from a mix of high temperature grog and about one third fine, low temperature calcined oxide. Wax is used as a lubricant in the mix and, after pressing on a high pressure press with polished dies, the wax is carefully driven off with moderate firing schedules and final firing of the body can be carried out as high as 3,600°F.

Beryllia crucibles are useful in the melting of pure metals as the low reactivity retards contamination while the high working temperatures and shock resistance ease techniques. The literature takes note of the health hazards with special reference to the unpredictable susceptibility of certain individuals to dusts or vapors of the metal and its compounds and for this reason precautions should be taken to prevent exposure.

Binders

A fairly large group of organic materials which can be used in processing all types of clay and non-clay bodies to affect the mixing, forming and drying characteristics. On firing, the binding material is oxidized and leaves the body without entering chemical combination with the materials of the body, although the physical make up of the fired body may be radically affected.

By proper selection of binders an operator can:

1. Increase water of plasticity.
2. Decrease water of plasticity.
3. Increase green strength.
4. Increase dry strength.
5. Increase fired strength.
6. Increase hardness in the green and dried state.
7. Change the rate and total absorption of fired ware.
8. Change shrinkage in the dryer and kiln.
9. Reduce power required for forming.
10. Reduce warping, chipping and cracking.

All of these effects tend to improve the recovery of first class material from the kiln. Those few plants enjoying a 100% recovery, of course, have little to gain unless greater drying and firing rates are desired, but as dryer and kiln losses rise the economic justification of binders becomes evident.

A number of materials are available which will affect the raw clay. A program of testing should be carried out to determine the most economic with any particular clay. Different clays react quite differently with the same treatment and what proves to be best in one instance is not apt to be so in the next.

A preliminary study indicates that the following materials should be considered in any binder study.

1. Natural gums
2. Alginates
3. Waxes
4. Alcohols
6. Celluloses
7. Lignins

Gums, because of their relative high cost, are seldom used in structural units; however the gum group, which includes arabic, tragacanth, ghatti, locust seed and karaya have been used for many years as binder to improve adherence of glazes and engobes to green and dried ware and in such application should be considered.

Another high cost group of binders are the alginates. These materials are hydrophilic colloids derived from sea weed such as kelp from the Pacific coast. For the most part these binders replace the natural gums in glazes and engobes. Small additions have pronounced effects.

Waxes are derived from both vegetable and mineral sources. Used in the form of emulsions the waxes may be used singly or in blends. The effect is twofold: in addition to serving as a binder they act as a good lubricant to bodies of little plasticity. In dust pressing, close size tolerances can be maintained, dry press operations can be carried out under higher pressures without pressure cracking and in stiff mud extrusion, laminations are reduced. Waxes have been specially developed for use in glazes and engobes to improve rub resistance.

Flours and starches are prepared from vegetable sources; potato, wheat and rice have been used but corn starch and corn starch derivatives are popular because of cost and ready availability as well as the wide range of corn products offered.

Dextrines are sugars converted from starch by acid treatments and are used in specific applications in the same way as starch.

In extruded materials, various dextrines and Corn Products' Hydrocor brand binder are used to obtain added strength while green and during the first stages of drying. Globe brand dextrine, which can be used in this application, requires one to three pounds per ton of clay. It is a powder and highly soluble in water. Hydrocor and dextrines are used in the refractory field, but here the plasticizing effect of the material is more important than the added strength.

Some corn cereal binders are used to reduce loss in the production of sewer pipe. A product used in this application is Mogul cereal binder, a pregelatinized corn starch product containing 5-7% corn protein. It is powder in form. Approximately ¼ of 1% is used to obtain maximum green strength.

The same material is also used in the production of face brick to cut losses. An addition of 1% can cut breakage 100% and only ½ of 1% will reduce such breakage significantly.

Polyvinyl alcohol is a white, water soluble powder which possesses excellent adhesive and binding characteristics. Films cast from aqueous solutons of polyvinyl alcohol have extremely high tensile strength and are impervious to oils and greases. By varying the conditions during manufacture, it is possible to produce a series of polyvinyl alcohols differing markedly in physical properties. The principal factors governing these properties are the degrees of polymerization and hydrolysis.

With each viscosity or polymerization range, several grades of polyvinyl alcohol are produced by varying the degrees of hydrolysis of the polyvinyl acetate. Of those hydrolyzed, about 99% or greater are generally referred to as "completely hydrolyzed," while those hydrolyzed to a lesser extent are referred to as "partially hydrolyzed" grades.

The two grades of Du Pont's polyvinyl alcohol generally used as binders for clay are "Elvanol" 72-60 and "Elvanol" 71-30. Where economic limitations are severe it can be combined with starch to reduce costs. For initial trials, one part of PVA to nine parts of a low viscosity, oxidized starch is suggested. Even in smaller proportion, "Elvanol," mixed with starch, will produce a noticeable improvement in binding characteristics over starch alone.

Methylcellulose, a synthetic gum, is an effective binder for refractories, structural clay products and abrasives. In addition, it functions as a lubricant, wetting agent and plasticizer. As a film former it toughens unfired glazes and improves bonding.

It has been used as a body addition and is highly regarded as a component of refractory mortars were its water retaining properties increase workability.

Both Du Pont's CMC and Dow's Methocel are produced in a range of qualities and viscosities with different effects. For this reason, product literature should be studied to insure economical results.

A large number of wood extracts are offered and because of their low cost, are logical products for consideration by structural producers who have production of large tonnages.

These products are available as liquids and powders, both relatively refined and unrefined and exhibit a rather wide range of properties.

Some are calcium based, some are sodium based and with different clays results may be expected to vary. The degree of sulfonation is also subject to control.

Lignins should be added, as all binders, with accurate feeders as the actual addition is very small and variations in the rate will produce problems greater than the original ones.

Lignins are by-products of the paper industry and have been used in the structural clay industry for many years. A sewer pipe manufacturer reports elimination of a high cost plastic clay, added at a 30% rate, when a ½% addition of "Goulac" a Rabeson Process Co. product was used and several face brick manufacturers have indicated a 50% reduction in pugging water while using Kimberly-Clark's "Additive A."

Mixtures of binders from the different classes sometimes are much more effective than when either is used alone. A laboratory testing program should be undertaken by producers interested in binders with the idea of determining most promising binders for plant scale trials.

Body Stains

They are combinations of various oxides calcined together at high temperatures. The most common system is composed of oxides of chromium, antimony, and titanium, which yields a wide variety of yellow, tan, and brown shades. A uniform color through the body is produced by mixing the body stain with the raw material before forming. Cobalt aluminates or silicates are used for blues, manganese alumina calcines for pinks and chrome based stains for greens.

Prepared stains used to color the whole body or used in an engobe to cover the body.

Blues—are cobalt based with alumina, silica, and zinc additions.

Turquoise Blues—are Zr-V (patented composition).

Yellows—are Zr-V, best for uniformity and non-bloating characteristics, Sn-V which give the cleanest colors, and Ti-Cr-Sb types which are very strong but bloat in most bodies.

Greens—are Cr based or blends of Zr-V turquoise and either Zr-V or Sn-V yellows.

Tans—are usually blends of pink and yellow stains or in some cases Fe-Cr-Zn browns.

Browns—are usually blends of pink, yellow, and Fe-Cr-Zn browns. This latter type stain is not too stable.

Blacks and Grays—are made of natural iron chromite but calcined stains of like composition are more uniform and eliminate the variation found in natural materials.

Pinks—are generally Mn-Al calcined stains of good strength and uniformity.

Borax

$Na_2O{:}2B_2O_3{:}10\ H_2O$. Practically all American Borax comes from California. The mineral tincal is mined in the Mojave Desert and is processed and marketed as Borax. Borax is also prepared by the evaporation and purification of brines from Searles Lake. It is soluble in water and soluble in acids and melts in its own water of crystallization. It has a mol. wt. of 381.43, sp. gr. of about 1.72 and a hardness of 2.0-2.5.

The water of crystallization is eliminated during fusion with other ceramic raw materials, leaving 52.8% by weight of sodium and boric oxides to form part of the ceramic composition. The purity of ordinary commercial borax is guaranteed over 99.5%, the original impurity being largely clay. It is obtainable in large crystals, powdered, and granular form. The last being regarded as the most practical and economical for ceramic use.

Anhydrous or fused borax, $Na_2O : 2B_2O_3$, melts at 736°C and is soluble in water, its rate of solubility being considerably slower than borax at 20°C but about the same at 60°C. Theoretically it contains no water of crystallization, and actual analyses show less than 0.5% water. Anhydrous borax may be substituted for ordinary borax, approximately 53 lbs. being equivalent to 100 lbs. of the hydrated material. Unlike borax, it does not puff or swell to a light fluffy mass during the melting operation, and therefore its use minimizes segregation and loss, particularly in furnaces operated under strong drafts.

Borax is widely used as a flux for glazes on ceramic bodies. The boric oxide shares with silica the property of combining with bases to form glassy compounds after fusion. The readiness with which boric oxide combines with bases finds application in the production of pottery colors from metallic oxides; the shades obtained often vary according to the percentage of boric oxide used. It also has an important function in reducing the viscosity of glazes; by the addition of a little borax, the most viscous glazes are made to heal better. Borax also tends

Clay Modifiers

to produce higher gloss in a glaze and lowers the maturing temperature.

Borax is used mixed with salt in vapor glazing of sewer pipe and structurals. In most cases the optimum amount of borax is 10% and the balance salt. The mixture is applied in the same manner that salt alone is used in salt glazing. The major result is a reduction of crazing and pinholing with a significant increase in glaze thickness. (See anhydrous rasorite.)

Boric Acid

$\frac{1}{2}(B_2O_3{:}3H_2O)$. Boric acid is produced by treatment of borax with sulfuric acid and occurs, in limited quantities, as the mineral sassolite in Italy. It is not as economical a source of boric oxide as borax. It can be used where the addition of sodium must be limited.

Calcined Clay

Any clay when heated to a ow red heat loses many of its claylike properties; the ability to form a plastic mass is probably the most important followed by the permanent red tion in size. Strictly speaking, grog, made by gr ding cull fired clay bodies and calcined clay e identical but their physical condition may vary within wide limits.

Calcined clay can be prepared by passing through a rotary kiln or by any of a number of batch methods. Power to form a plastic mass is last around 1,200°F but the ultimate shrinkage is not reached until the material is heated to much higher temperatures. This ultimate temperature will vary with different clays and its necessity will depend on the use to be made of the resulting material.

The addition of calcined clay to highly plastic clays will reduce the plasticity of the mixture to any desired point. In the production of structural products it will increase the production rates from grinding, tempering and extrusion operations. By reducing shrinkage in the dryer and the kiln, serious production bottlenecks can be overcome with an important increase in quality.

An important percentage of refractories contain calcined clay usually in the form of grog. (See Grog.)

Calcium Carbonate. (See Lime)

Calcium Fluoride. (See fluorspar)

Calcium Aluminate

A pure hydraulically setting calcium aluminate cement is available for applications requiring high refractoriness. This material is made from Bayer process alumina and high-grade lime and contains less than 2% total impurities. It contains 80% Al_2O_3 and 18% CaO. A typical chemical analysis is as follows:

CaO	18%
Al_2O_3	80%
Fe_2O_3	0.4%
SiO_2	0.1%
Na_2O	0.5%
MgO	0.4%
S	0.06
Ignition Loss	1.0

PCE — 34 (3205°F.)

This cement can be used with conventional fire clay grogs as well as super refractory grogs such as Tabular Alumina. The hydraulic compounds formed in setting are $CaO \cdot Al_2O_3$ and $CaO \cdot 2Al_2O_3$. These have high bonding strength at room temperature and above. At 2000°F the hydraulic bond is destroyed but ceramic bonding then takes place and high strength continues up to the softening point, 3200°F.

Pure calcium aluminate cement has appreciably higher strength than impure calcium aluminate made from bauxite in the critical temperature range, 1500 to 2000°F., where the hydraulic bond is lost and the ceramic bond is not yet formed. In fact pure calcium aluminate cement with a grog of Tabular Alumina, 15% cement and 85% Tabular Alumina (Cal Tab 15) has even higher strength at 2000°F than at room temperature, as shown in the following data:

Cal Tab 15	Modulus of Rupture (psi.)
As cast, 24-hour cure	650
Fired 5 hours at 2000°F.	1200

Calcium Oxide. (See Lime)

Calcium Sulfate. (See Plaster of Paris)

Carbon

A growing number of refractory brick are being tory material. Coke ground and graded is a popular source of the material, which is held together with tar. These brick are used in the metal producing industries in places where they are protected from produced that contain elemental carbon as the refracexposure to oxygen. Used with reason, carbon brick are reported to offer outstanding advantages of high refractoriness, low and uniform expansion under heat, and high thermal shock resistance.

In addition to coke they can be made of charcoal, anthracite, petroleum coke or graphite. Tar binder is mixed with the carbon and pressed with mechanical presses, dried in unheated rooms and fired in kilns from which all oxygen is excluded from the setting.

Clays

Clays are chiefly made up of hydrated aluminum silicates. The most common of these is the kaolinite group ($Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$) and the montmorillonite group ($Mg, Ca)O \cdot Al_2O_3 \cdot 5SiO_2 \cdot nH_2O$.

There are two types of clays, the residual and secondary. The residual occurs in the place where it was developed by weathering. Secondary clays are transported from the original site by water or other means as ice and deposited in a remote area.

The pure kaolinite and montmorillonite clays are made of very minute plate-like structures, and these plates are responsible for the plasticity of the clay when mixed with water.

The normal behaviors of clays in the ceramic process is to develop plasticity, have a formability, have a rigid state and fire to a stone-like hardness, developing various colors.

The exceedingly high content of fine particles is characteristic of very plastic clays, and has a direct relationship to their working properties. The finest portion contains the clay suspensoids or colloids which are responsible for the plasticity. The greater part of this fine material consists of granular material while the colloids are really only a very small amount. A high content of the so-called clay substances is sometimes accompanied by an excessive degree of plasticity which renders a clay sticky and difficult to work. Other very important factors in plasticity are the amount, size, relative proportion of sizes, shape and character of the granular material, and the amount and character of the soluble salts, i.e., electrolytes present.

The influence of the fineness of grain of a clay is not limited solely to its relation to plasticity, but extends to other properties, namely, drying conduct, drying shrinkage, warping, tensile or transverse strength and bonding strength.

It may be said that the greater the proportion of the fine material, the slower the rate of drying, the greater the shrinkage and the greater the tendency to warping and cracking during this stage. It is the usual practice to mix these clays with coarser materials which overcome these difficulties.

If we compare two clays of different degrees of plasticity, we find that the more plastic requires more water to make it workable and that the loss of water in the drying operation takes the place more gradually because of the very extensive capillary system. Also we find that there is a greater shrinkage in the highly plastic clay.

Clay, Ball

Ball clays are aluminum silicates found chiefly in Kentucky and Tennessee. They are very plastic sedimentary clays which are fairly refractory, maturing from Cone 18 to Cone 34. It will burn to a rather near white color. Some ball clays will vitrify as low as Cone 8 and 10.

The refractories industry is a large user of ball clays, particularly in the ramming mixes, castables and plastic refractories. Since all of these must be put in place and remain rather hard before being matured in clay, such as ball clay, which has high plasticity and high dry strength, is used to develop the strength of this refractory in dry state. Ball clays are very workable into shapes and holds its shape after once formed.

Special refractories which require a great amount of prefired grog material need some plastic clay to hold the shape of a brick or a special shape. This plastic is ball clay. In some cases, as little as 10 or 15% ball clay is used to suspend 85 to 90% of grog.

Some ball clays are used in engobes to decorate brick and tile. Since ball clays are quite plastic, they are moderated with flint and color to match body shrinkages of brick and tile and make a good coating surface in any color.

Ball clays are used normally in the heavy clay products industry for their plasticity in the working stage, and for dry strength in the dry stage. In some instances, in colored brick surface.

Chromium Oxide

Cr_2O_3. Mol. wt. 152, sp. gr. 5. A bright green crystalline powder insoluble in acids and alkalies.

Chromium is used mainly to impart a green color. It is often introduced as a chromium oxide or potassium dichromate, but the dichromates of sodium and ammonium and the chromates of potassium, sodium and iron find occasional use.

In glazes, chromium oxide, or other chromium compounds, are commonly used to produce green colors. The oxide itself is generally used in raw glazes while potassium dichromate is more common in fritted glazes. An oxidizing fire must be provided to avoid development of a black color.

In such glazes, zinc oxide will produce a brown color, due to the formation of zinc chromate, and high lead glazes will form the yellow lead chromate. Tin oxide, of course, cannot be present, as it will form the chrome-tin pink.

Coal

This is an amorphous form of carbon and has its origin in vegetable matter which has become decomposed by chemical activity and often pressure. Widely used as a fuel in the structural and refractory industry, it has been replaced by gas or oil in many plants.

It is used as a grog-like material in some plants to expedite forming of brick. In this use it acts to reduce lamination due to the keying action of the coal particles promoting greater production and better quality. Due to the sulphur content, it can add to the scumming problems of a producer.

All of the heat value is recovered from the coal which can be added in the pug mill or can be ground with the clay in the grinders. Some clays are naturally rich in carbonaceous material, similar to coal, and furnish much of the heat required to raise the body to the maturing temperature. An additional effect of the coal is the reduction of the unit weight of the ware.

Coal also serves as the raw material for the production of coke, which can be used in brick similarly and which is also used in the production of light weight aggregate and as a raw material for the manufacture of carbon refractory brick.

Anthracite coal can be used for the fuel in lightweight aggregate production; in this use, the ash becomes part of the product.

Cobalt Oxide

Co_2O_3 : CoO. Mol. wt. 240.8 and sp. gr. 6. Insoluble in water and most mineral acids, but soluble in sulfuric acid. This black powder is obtained by roasting cobalt ore from Northern Rhodesia, Morocco, Burma and Canada in order to drive off arsenic and sulfur, and then, by separating the residue from the nickel and other constituents. It is also produced by a roasting and leaching process from Cobalt-bearing Iron Pyrite mined at Cornwall, Pennsylvania.

Cobalt oxide is widely used in the ceramic industry as a source of colorant for glass, glaze stains, body stains and engobe stains. Best results are obtained by first calcining intimate mixtures of cobalt oxide with such other ingredients as aluminum oxide, silicon dioxide, zinc oxide and magnesium oxide. The above produces straight blue stains going toward the green as the zinc oxide is increased and going toward the purple as the silicon dioxide and magnesium oxide are increased.

By adding chrome oxide to the above, shades of blue green are produced.

Cobalt oxide calcined with combinations of iron oxide, chrome oxide, nickel oxide and manganese dioxide produce shades of gray and black.

Stains can be used in connection with glazes, which are compounded from alumina as a base, with lighter blues than the usual cobalt are obtained. In the case of high cobalt content, there is a slight tendency toward a greenish tint when low fire is given. In proper combination with MgO, SiO_2, and B_2O_3, a beautiful red, violet, lavender or pink color can be obtained. Cobalt in combination with manganese is also used in the production of black spots on terra cotta glazes.

Cobalt Sulfate

This material can be used to impart a blue or blue-white color to white bodies. The sulfate is dissolved, added to the body and then precipitated with sodium carbonate. The effect of as small an amount as one pound of cobalt sulfate on one ton of clay will be noticeable.

Colemanite

A natural hydrated calcium borate 2 CaO : $3B_2O_3$: $5H_2O$. It occurs in California and Nevada and was formerly the chief domestic source of borax and boric acid.

Colemanite can be used very satisfactorily in many raw lead glazes where the addition of CaO and B_2O_3 is desired without using a frit. It is especially useful in the development of some pink and maroon red glazes, both matt and bright, at temperatures from Cone 01 to Cone 07. It has been found that this material can be used in place of high whiting content and that it will bring out better shades of pinks and maroon in commercially prepared stains.

Copper Oxide

Two materials, Cupric oxide, CuO, or Cuprous oxide, Cu_2O, are used as a source for copper oxide. Cupric, insoluble in water is derived by the ignition of copper carbonate or copper nitrate, copper hydrate, or oxidation of lower oxides. Cuprous is prepared by the oxidation of copper, by the addition of bases to cupous chloride, or by the action of glucose on cupric hydroxide or upon copper scale.

Cupric oxide, when used in glazes, has a wide range of color. It may be used either as the raw oxide in a raw glaze, as the raw oxide in a fritted glaze, or as a part of the frit itself. It is used equally well in any of these case, but, when mixed with the frit, there is a loss of color strength under certain conditions due to volatilization of the oxide, and it is not so satisfactory above Cone 4 when operations are carried out under oxidizing conditions.

Copper oxide is the only individual pigmentary oxide in common use which in practically every combination and under ordinary conditions produces clear green colors. In combination with tin oxide and other opacifying agents, it gives turquoise or blue-greens when the glaze is alkaline.

The amount of copper oxide in the glaze for light shade of green will be 0.03 to 0.06 equivalents, and for darker shades from 0.06 to 0.10 equivalents. The variable amount will depend almost entirely upon the composition of the RO group. In glazes containing PbO in fairly large amounts, smaller than normal amounts of copper oxide are used.

Copper Carbonate

$CuCO_3$: $Cu(OH)_2$. It is derived from the interaction of sodium carbonate and copper sulfate.

Copper

Copper carbonate is used to introduce copper colors into glazes, especially in cases where, instead of getting the blues and greens of copper oxide, it is desirable to get the lavenders, reds and purples obtainable under reducing conditions. A brilliant red glaze is produced with 0.2-1% copper carbonate, 1% tin oxide and a reducing agent of 0.2% silicon carbide.

If, in the same glaze, the silicon carbide is omitted and the stannic oxide increased to 5-7%, a blue results, thus allowing the development of copper reds and blues or greens on the same piece.

Cordierite

Cordierite is a magnesium aluminum silicate with the following formula: ($2MgO$: $2Al_2O_3$: $5SiO_2$). Its specific gravity is rather high, ranging from 2.6 to 2.7 and it is the hardness of colindite ranging from 7.0 to 7.5 on the Mohs scale.

Although cordierite is found over the world, it is chiefly developed in clay bodies by adding talc to a rather pure clay.

Cordierite, which is theoretically 39.6% talc, 47.0% clay and 13.4% alumina, has an extremely low coefficient of expansion. It can be heated up very rapidly and cooled down very rapidly. Repeated heatings and coolings do not affect it.

By itself, this composition has a very short vitrification range and must be fired very carefully. In fact, it cannot be fired too successfully in commercial kilns. Zirconium silicate is used as a modifier for this body, giving it a better firing range so that it can be fully developed in a commercial kiln.

Cordierite type compositions have been used for insulation in high temperature operating mechanisms as motors, radar, and so forth. Its use in general run of refractories is yet to be developed to a high degree.

Cristobalite

SiO_2. A crystalline all tropic form of silica, formed by heat treatment of silica to 1,470° C. Cristobalite, as a natural mineral, is very rare, but the material is important in the ceramic industry because it is formed in most ceramic bodies during firing. The inversion from quartz to cristobalite involves an expansion of about 14%; therefore, highly siliceous ware must be treated with some care through the inversion point. (See Silica.)

Crocus Martis

An oxide of iron used mostly in the preparations of underglaze colors and sometimes in glazes as a coloring agent. It develops, when burned in an oxidizing flame together with other glaze constituents, a reddish-brown color.

Cryolite

A mineral, sodium fluoaluminate, having chemical composition NA_3AlF_6. The refined material is available as a minus 80 mesh powder in 100-lb. bags.

Cryolite can be used in clay products as an auxiliary flux. Its Fluorine content aids in dissolving silicates. As a mineralizer, Cryolite promotes Mullite formation. Cryolite is also a powerful flux and opacifier in glazes for special purpose bricks.

Used as a mineralizer or flux, Cryolite promotes denser structures and lowers maturing temperatures in clay tiles and bricks.

Cullet

Broken or powdered glass. Can be used in refractories to form an intermediate ceramic bond between where organic binders burn out and before high temperature binders begin to develop ceramic bonds.

Can be used in engobes or "sands" applied as facing treatments to brick and in this use the relatively low melting points serve to bind the coating to the body.

Deflocculant

Any substance which when added to a mixture of clays and water, will cause the mass to become more fluid is called a deflocculating agent. Or, more simply, deflocculant.

Deflocculants may consist of hydroxides of monavalent cations (such as $Na+$, $K+$, or NH_4+) or salts of these cations that hydrolyze to a base (Na_2CO_3 or sodium silicate). Or they may be organic colloids such as pyrogallic acid, tannic acid, humic acid or alkali salts of these materials.

Certain clays contain varying amounts and variable sorts of organic matter which can react with soda ash or caustic soda to form highly effective deflocculants. Variation in slip quality is often traceable to differences in the quantity of organic deflocculant produced from batch to batch, either because of organic variation or processing differences.

Colloidal silica is a potent "protective colloid" and for this reason the higher SiO_2 sodium silicates are more effective as deflocculants for a given Na_2O content than those lower in SiO_2.

Some nonionic colloids, notably gums and glues, can be used to disperse clays in presence of water. Starch is an especially effective deflocculant.

The sodium salts of the polyphosphate glasses are extremely efficient deflocculants and constitute a special case because they can produce very fluid slips at relatively low pH (under 5.0) and high solids (upwards of 70%).

Since deflocculants liquefy, several advantages are evident. Less water is needed to produce a given plasticity and flow. Less horse power is needed to extrude the clay. The body is denser as a result of less water content.

The deflocculant may be a flux and lower the maturing temperature of the clay.

Sodium silicate is a very important deflocculant in plastic refractories because it can develop plasticity without the addition of too much water. Also, sodium silicate dries very hard and assists the ball clay in developing the hardness necessary for plastic refractories, ramming mixes and castables. It probably is one of the chief ingredients in this flexible type of refractory.

Sodium silicate has been used in many instances in stiff mud extruding. Besides bringing out the good properties of a deflocculant, sodium silicate also has a certain binder quality which aids in making good clay products.

The use of sodium silicate with the make-up water and dry press mixes assists in binding the dry press body, besides increasing flowability in the die and good packing.

Dextrin

Used as a binder and plasticizer for clay products, dextrin is derived from starch by treating with acid while being heated. (See starch and binders.)

Diatomaceous Earth

Diatomaceous silica, diatomite, Kieselguhr, is a highly siliceous mineral derived from skeletons of microscopic organisms. It is mined extensively in California and Nevada. Desirable features of material are its closed cells and high porosity which give a low density and a low thermal conductivity. Fusion point is 1715°C. Density is .8 to 1.2. Occurrence is widespread.

Insulating brick are made of this material by three methods. One type of brick is cut directly from the deposit and used in temperatures up to 1,500°F without shrinking. Where high temperatures are experienced, the brick cut from the deposit are pressed from the dust and prefired from 1,800 to 1,950°F to shrink them. Fired over 1,950 the brick develops spalling tendencies. To avoid the objectionable cristobalite form of SiO_2, which causes spalling, the brick is fired to 2,500°. To this brick is added 1 to 3% lime as a catalytic agent, and the brick is called tridymite brick. Grog, spar and clay are also included in the formula.

Dolomite

$CaMg(CO_3)_2$. Dolomite is a rock intermediate in composition between limestone and magnesite. It has a specific gravity of 2.9 and hardness of 3.5-4.0. The true material is composed of 56% calcium carbonate and 44% magnesium carbonate. There are, however, other materials containing appreciable amounts of magnesium carbonate, but less than the 44% present in pure dolomite, these are commonly called limestones and are used in the ceramic industry.

In the raw state, dolomite may be light buff, pink, yellow to brown and gray to blue. Its physical structure may be either crystalline or amorphous. When fired, dolomite is white; it decomposes to

Clay Modifiers

magnesia and calcium carbonate at 1,350-1,450°F. At about 1,650°F, all CO_2 is expelled, and the material burns to dolomite lime (CaO : MgO). In the presence of lower melting fluxes of acid character, it frequently decomposes at still lower temperatures.

Commercial deposits of dolomite are well scattered with important ones being located in Ohio, New York, Connecticut, California, Pennsylvania, Missouri, Texas and Kansas.

In general, dolomite may be substituted for nearly any other type of lime flux in glazes when other batch constituents are properly compensated. In ceramic bodies it promotes a glassy bond reacting with feldspar, flint and clay in the range of Cone 1 to 12 to form a lime glass. This property is of particular value in promoting the maturing speed, especially under rapid firing schedules.

The amount to be used varies with the vitrification desired and the firing temperatures, but the range of ½ to 8%, based on dry body weight, covers most vitreous and semivitreous bodies. Frequently a reduction in feldspar, with compensating increase in flint, seems to be possible. When dolomite is used to replace whiting, the safe firing range is widened by 1 or 2 cones. In combination with other fluxes, dolomite is effective as low as Cone 03-04 and is in use as an auxiliary in those clays which carry variable amounts of alkaline earths. In such bodies, it acts as a stabilizing flux and tends to widen as well as lower the firing range.

Electrolyte

For ceramic applications, an electrolyte is an acidic, basic or neutral substance capable of dissociating partly or completely into ions in water solution. The basic electrolytes promote deflocculation whereas the acidic and neutral compounds usually bring about flocculation of clay-water dispersions.

Thus the type and amount of electrolyte can be used to govern the character of ceramic slips and bodies and thus influence plasticity, casting qualities, dry properties such as strength and fire properties. Examples of basic electrolytes are caustic soda, soda ash and sodium silicate. Acidic electrolytes may be acids such as HCl or acid salts such as NH_4Cl. The neutral electrolytes are salts of strong acids and strong bases such as NaCl. (See Deflocculants.)

Engobe

An engobe is a clay or mixture of clays, fluxes and nonplastics which can be applied to a clay body such as a brick or tile which can be tinted any color and will cover small defects on the face of the body. Engobe can be used between the clay body and a glaze surface to mask the natural color of the body.

However, in structurals, engobes are of interest when used to color the ware and to change the appearance or texture of the unit. Many common clays can be used in the preparation of engobes in which case they should be finely ground or, if easily slacked, mixed with water and blended. All particles not passing an 80 mesh screen should be reground or discarded. To this base material, feldspar, calcium carbonate and flint are commonly added to affect shrinkage, softening point and refractoriness of the engobe.

If local clays are not available that have compatible colors, which usually means light firing shades of buff or white, commercial ball and china (kaolin) clays can be used for the base material. Due to the comparative high purity of these clays, preparation is simplified but they might not be as easy to "fit" to the body as local clay.

Engobes are sintered or vitrified to a greater or lesser degree and differ from glazes in that the glassy phase is not strongly developed. Other modifiers that can be used are magnesium carbonate, barium carbonate, bone ash, zinc oxide, mica and lead oxide.

Engobes can be applied in a number of ways to bodies in the green or dried condition or even to a prefired body if that should for some reason be desired. Engobes may be applied by dipping, rolling, brushing or spraying.

Any of the common coloring oxides can be used to affect the fired color of the engobe, or local occurring materials can be used. Colors that do not contrast with the body color are preferred as small chips and imperfections are not as critical. The pallet of colors is practically unlimited, however.

Engobes do not stick badly in the kiln if properly formulated. Coarse sand can be mixed with them for fine architectural effects. They can be applied over practically any texture.

Epsom Salts. (See Magnesium Sulfate)

Feldspar

Feldspar is the most common mineral in the crystalline rocks. The feldspars form a group of which the principal types are orthoclase, microcline, albite and anorthite. These are aluminum silicates of potassium, sodium and calcium. Chief commercial sources of supply are North Carolina, South Dakota, Colorado, Maine, Virginia, Arizona and Connecticut.

Free quartz acts as a dilutent in feldspar and decreases the fluxing power. In unburned ceramic bodies, feldspar acts as an anti-plastic the same as sand does. Soda feldspar and quartz mixtures deform much more rapidly after deformation begins than do the potash feldspars or any of their mixture with quartz. High soda content, in general, indicates low deformation or low fusion temperature. The fusion point of a feldspar depends upon the alkalis present and becomes lower as the soda content increases and the potassium oxide content decreases. Some spars fuse as low as cone 4; others as high as cone 10 but the general average fuse at cone 8 to 9.

Feldspar is frequently said to be a universal flux used in all types of ceramic bodies.

Feldspar is widely used in glazes for structural clay products including facing tile, ceramic sewer pipe glazes, terra cotta, etc. Its role in glazes is to provide fluxing action and it should be finely ground for this purpose. Generally a material that is ground to at least 98% finer than 200 Mesh is purchased and this, of course, is subjected to additional grinding with other glaze ingredients in ball mills prior to use. Both potash and soda feldspars are used in glazes but preference in most instances is for a potash type. Potash spar is desirable because it dissolves the silica more readily and makes a more durable glaze. Soda feldspar has an advantage of making a smoother fired glaze.

In recent years specialty face brick and tile in a wide range of pastel colors and white and black have been produced commercially using potash feldspar as a major ingredient in the ware itself. In this application the finely ground feldspar from Custer, South Dakota, acts as a major flux which allows earlier maturing of the clay body. A secondary role is to act as an extender for the expensive mineral oxides used as coloring agents in these brick.

Several face brick manufacturers have developed "sand coatings" or "granular coatings" for red burning brick. These coatings impart attractive color and texture to red burning ware. Feldspar is a major ingredient in many of them. It acts as an extender for the expensive coloring oxides. However, its major function is as a flux to form a fired bond between the coating and the brick itself. Soda feldspar is preferred due to its lower fusability.

Fine ground feldspar rejects have been used in some buff and red burning face brick to provide greater vitrification and lower fired absorption at lower temperatures. In experimental work done at Clemson College, additions of low cost feldspathic brick flux in amounts from 2.5 to 10% resulted in equivalent porosity for the brick with the additive from three to five cones lower. Additions of from 5 to 10% of brick flux prepared from feldspathic waste material improved the fired modulus of rupture of the structural clay product body by 10 to 25%.

The work of Clemson College by the Dept. of Ceramic Engineering showed that the fineness of the flux which is added is at least as important as the chemical composition. In the case of the feldspars studied at Clemson, 200 Mesh feldspar from Kona, North Carolina, and 200 Mesh feldspar from Bedford, Virginia, gave more outstanding results than did coarser grinds of the same materials.

Flint

SiO_2. A black, gray, or brown cryptocrystalline variety of quartz. It commonly occurs as nodules, either with calcareous coating in clay or as coarse pebbles along a seashore where the coatings have been removed by attrition. The dark color of flint is probably due to carbonaceous matter. The mineral breaks with a characteristic conchoidal fracture, is readily soluble in alkaline solution at 200°C, and is soluble in fused feldspar. Flint pebbles are quarried along the coasts of Denmark, France, and England. It should be clearly understood that in the United States ceramists often employ the term flint to include other siliceous minerals in addition to true flint; "sand flint," "rock flint," tripoli flint," generally called potter's flint, are various types of ground sandstone and quartzite, not true flint, but utilized in exactly the same way.

Fluorspar

Fluorspar has a long history of utilization as an active fluxing agent in ceramic wares, especially in glasses and enamels, as well as in glazes and porcelain bodies. These uses demand a higher purity fluorspar containing upwards of 90% of the mineral, fluorite. When used as an additive to heavy clay products, the purity is secondary in importance to the fineness of the fluorspar.

Fluorspar has been found to be the most economical, most effective, and most easily usable additive for the prevention of green efflorescence in light firing ware. Its effect is twofold. Through its fluxing action, it promotes earlier vitrification and consequent lower porosity in firing, thus reducing subsequent movement of soluble vanadium salts to the surface of the ware.

Secondly, through reaction with compounds of vanadium, insoluble compounds are produced, or, in some instances, volatile phases result which are driven off during firing. In each of these events, the result is the successful prevention of green colored efflorescences.

The amount of the additive necessary can only be determined through trial testing. On the average, about 1 per cent by weight is normally sufficient for control, although 2% to 3% may be required in certain difficult cases.

In addition to its ability to curb green efflorescence, fluorspar has been noted: to reduce white efflorescence due to soluble sulfates; to deter colored efflorescences due to molybdenum; and to prevent brown staining caused by manganese compounds. In all instances of its use as an additive, even firing, through good temperature control techniques, is essential to prevent over-firing or undesired deeper colors of light wares.

In its most common use as an additive to light firing brick, tile, etc., Ceramic No. 2 grade fluorspar is of sufficient purity. A very fine-grained fluorspar, essentially finer than 325 mesh, is marketed under the name "Superfine." Also available is a fluorspar treated to improve its wetting properties. The properties of fineness and wettability of this additive are desirable because, unlike some efflorescence deterrents, fluorspar is quite insoluble. Again, for this reason, the fluorspar should be added early in the clay preparation technique to insure intimacy of mixing with the clay. The admixture is best done in the secondary grinding stage, for example, at the

dry pan.

Incomplete mixing will result in local concentration of this strong flux within the ware giving rise to heterogeneous maturation upon firing. Local aggregation of the flux can cause spalling of the ware due to differential maturity within a single unit.

Fluorspar is a name most accurately applied to nonmetallic mineral aggregates which contain a large amount of calcium fluoride, CaF_2. Calcium fluoride, in fluorspar, constitutes the mineral, fluorite, containing almost equal percentages by weight of the elements, calcium and fluorine. The mineral fluorite is a glasslike substance, translucent to transparent, even opaque at times, and ranging in color from colorless to bluish through varying shades of violet, purple, green, and yellow.

As found naturally, it is crystallized into well-formed cubical shapes and it cleaves readily into octahedra. Mined as fluorspar, it is commonly associated with many different accessory minerals and must be processed by various types of beneficiation techniques. Most commercial domestic fluorspar is mined in Kentucky and Illinois.

Flux

A flux in ceramics as well as other compounds is a material which lowers the fusion point of any mixture in which it is present.

For instance in certain castable plastic and ramming refractories, glass is used as a flux to melt the particles of clay together at a low temperature and form a hydrofractory in place earlier.

Certain materials as feldspar, volcanic ash, nepheline syenite will act as a flux on high temperature firing clays to lower their temperatures of maturing in the manufacture of brick and tile.

Certainly fluxes are very important in developing glazes on brick and tile. Lead is generally the chief one of these fluxes. Lead silicate, a commercially prepared combination of lead and silica, is used for fluxing glazed materials. Boric acid, borax, soda ash are some of the other materials used for fluxing glazes.

Frit

A glassy material produced by fusing a mixture of some or all of the constituents of a glaze or enamel so as to render insoluble any soluble materials present, and also to insure greater homogeneity, to lower the melting point, and to render toxic compounds non-poisonous.

To qualify as frit, the glassy material must be in a granular form, for the word derives from "Fritting," the process of quenching molten glass.

In glaze work it is often necessary to use low-fire leadless glazes, and here the frit plays an important part. In most low-fired glazes, soluble materials are necessarily used, and fritting renders them insoluble. A fritted glaze of the low temperature type is said to be more stable than a low temperature raw glaze.

Glazes

Generally homogeneous, thin silicate mixtures fused on the surface of a clay body. They are glasses in their physical and chemical nature, hard, slightly or completely insoluble excepting in strong acids or bases, impermeable to gases and liquids. Like glasses they are not definite chemical compounds but complex mixtures which sometimes are described as undercooled solutions since many of their properties are analogous to those observed in ordinary solutions.

Glazes are more or less lustrous. Generally the surface is highly reflective or glossy, but the matt glaze has a surface which has been compared, quite accurately, with the appearance of a glace kid, and all gradations of glossiness or mattness may be observed.

Glazes may be colored or colorless, transparent, translucent, or opaque. Whatever the appearance, the glaze or similar coating is used on clawares to make the ware impermeable to liquids and gases and/or to provide a decorative effect. Designing of glazes to "fit" any given body is a complex problem involving variables of temperature maturity, expansion under temperature, viscosity, toxicity and color.

Glaze Stains

Made by calcining the common metallic oxides with modifiers. They are used by mixing from 1% to 8% of the stain with a glaze before it is applied to the body to give a uniform color throughout the glaze layer. New developments in recent years widened the color range so that now a fairly complete color palette is obtainable with glaze stains over quite a wide range of firing temperatures.

Glue

An impure form of gelatine which can be used as a binder both for glazes and for bodies. (See Binders.)

Grog

Generally any clay-like material that has been fired to a temperature where the characteristic plasticity is destroyed. Used in structural production it serves to eliminate laminations, makes drying and firing faster and with less shrinkage.

It is much used in refractories, terra cotta and sewer pipe. While strictly speaking grog includes calcined clay, generally the latter is excluded from the classification. Grog can be made from cull material or pieces especially made and fired for this use. Grinding is expensive due to the high wearing rates and mixes containing grog can be very abrasive. This tends to retard its use but excellent results can be expected when the added costs are not prohibitive.

Gypsum. (See Plaster of Paris)

Glucose

A vegetable sugar that can be used as a binder in clay bodies. It is a Carbon-Hydrogen compound that exhibits similar properties as starch and dextrine. (See Binders.)

Iron Chromate

$FeCrO_4$. Mol. wt. 171.85. Ferrous chromate is used with cobalt oxide in under-glaze blacks, and also makes good black stains which may be added to a body. Iron chromate is also used to color engobes and has been a constituent of Cone 6 cherry brown and also dark pink overglaze polychrome. Brown and black colors in glass are also produced by iron chromate. Used as pigment for gray body stains.

Iron Oxides

FeO, ferrous oxide; Fe_2O_3, ferric oxide, hematite; and Fe_3O_4, ferrous-ferric oxide, magnetite. The oxides of iron produce dark brown colors generally. Very finely divided iron oxide is responsible for the red color common in clay products, but larger particles give brown or black slag spots which may detract from appearance.

For this reason, much expense and processing is incurred in the removal of iron oxide from all types of ceramic raw materials, sand, feldspar, nepheline syenite and practically all other white-burning minerals. Some work has been done on the removal of iron from clays by complicated procedures but none of these has as yet reached commercial production.

Heat treatment can affect the final color of brick containing even small percentages of iron. Mainly, these techniques are known as "flashing" and consist of manipulating the oxygen content of the atmosphere at certain critical temperatures.

Iron acts as a fluxing agent and small quantities can lower P.C.E. drastically and for this reason must be kept out of refractory products.

Kaolin

(China Clay) ($Al_2O_3 : 2SiO_2 : 2H_2O$.) This material fires to a white color and has a cone equivalent of 34-35.

The name, kaolin, comes from the two Chinese words Kao-ling, meaning "high ridge," originally a local term to describe the region from which the kaolin or "china clay" was obtained. The term was originally used in this country to refer to certain residual clays of a white or nearly white-burning character. In recent years, however, it has been stretched to cover certain white sedimentary clays like those obtained in South Carolina and Georgia. The present terminology differentiates between the two types of deposits by designating as primary or residual kaolins those white burning clays formed by the weathering, in place, of feldspathic rocks, pegmatite dikes, granites, and the like found in the location of the parent rock. Secondary or sedimentary kaolins are those that were formed by weather, then carried by water and redeposited in another area. Thus the secondary kaolins of South Carolina and Georgia were deposited in the sea, in an area later uplifted to form the Atlantic Coastal Plain.

Most of the domestic supply of residual kaolin is obtained from western North Carolina, and most of the sedimentary clay comes from Georgia and South Carolina. Many deposits of china clay are found in England and this material has for many years been a serious competitor of the domestic product. The American clay usually has finer grain and greater plasticity, therefore greater strength.

S. C. and Ga. china clay has been used throughout industry for years. It is one of the most uniform kaolins to be found. Generally speaking, there are two types of Georgia kaolin, one imparting unusually high strength and plasticity used where a high degree of workability is required. The other type, generally the fractionated controlled particle size clay, behaves well, dries uniformly, and reduces cracking of ware.

In 1950, 1,751,000 tons of domestic kaolins, valued at almost $24,000,000, were consumed in the U.S. Of this total it is estimated that the refractory industry uses some 9 percent.

When used as part of a refractory mix, the kaolin is sometimes supplemented with ball clays which improve the plasticity of the mix and strength. These improvements in handling characteristics are made with a sacrifice of refractoriness otherwise expected from kaolin used alone.

In many brick plants, local kaolin deposits are worked and the crude kaolin mixed with other clays or shale, to secure pastel colors. An additional effect of such mixtures is to raise the maturing temperature of the body and the range in which a satisfactory product can be produced. In the production of clay pipe, the increase of maturing temperature sometimes improves the glazing operation to a marked extent.

Kaolin can be used as a clay source in the preparation of engobes and slips. The extreme whiteness of the kaolin coupled with its high refractoriness allows the preparation of pastel colors maturing in a wide range of temperatures. In these uses, the low shrinkages during drying and firing are qualities that should not be ignored.

Kaolin, Florida

(Ball Kaolin). The kaolin deposits of Florida are found in the north central part of the state. They are mixed with white silica sand and pebbles. These deposits will average about 15% to 20% clay. When the sand and pebbles have been washed out, there is only 1½% to 2% clay solids in the stream going to the thickening vats. This provides a tremendous averaging effect and also results in a clay of high purity and cleanliness.

Florida kaolin has unusual physical properties not ordinarily associated with most kaolins. It can be described as a ball-kaolin. It has the refractoriness and high white fire color of kaolin coupled with the strength, workability and particle size distribution of a ball clay. This type kaolin has a greasy property that, together with a very fine particle size, gives it a very high degree of workability. It is very clean and uniform.

Florida kaolin is used in jiggering and extrusion processes where a high degree of workability is required. Excellent flowing properties make it very useful in dust press operation. It is used in bodies where high strength is required. It has excellent suspending power and is widely used in glazes. The low titanium content makes it desirable in colored bodies and colored glazes where greater purity of color in pastel shades is desired. Small percentages in casting bodies are helpful, acting as buffer for the electrolyte.

Kaolinite. (See Kaolin)

Lead Carbonate

(White lead). $PbCO_3 \cdot Pb(OH)_2$. Mol. wt. 776, sp. gr. 6.7, and decomposes at 400°C. Insoluble in water, slightly soluble in aqueous CO_2 and soluble in acid. It is a white powder, which is prepared by treating lead with acetic acid and carbon dioxide. The carbon dioxide is often generated by the fermentation of waste tanbark, which material sometimes gives a pink stain to the lead carbonate.

Modern methods of producing white lead use purified carbon dioxide produced by controlled burning of fuel and avoid the tanbark contaminations.

Lead carbonate is an important constituent of glazes. It is preferred by whiteware, earthenware and vitreous tile manufacturers to other lead compounds. Smaller amounts are used in enamels and

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glasses. Lead carbonate has advantageous purity, particle size, water dispersive and suspensive qualities. Fine size particles cause better suspension in raw glazes and quicker and more homogeneous fusions in frits. Due to high specific gravity of the oxides, difficulty in maintaining suspensions may be caused. The release of CO_2 and H_2O gas from lead carbonate under heat gives a degree of mechanical mixing and leaves the lead in a condition favorable to rapid chemical action which chemists describe as nascent. This is probably the cause for lead carbonate showing more rapid fusion.

Kyanite

(Cyanite) $3Al_2O_3 \cdot 3SiO_2$. This mineral has the same chemical composition as andalusite and sillimanite, but differs in crystal structure and physical properties. Kyanite has a specific gravity of 3.5-3.7 and a variable hardness, 4-5 parallel to the long direction of its blades and 6-7 across them.

It is found in India, Africa, Australia and in various parts of North America, particularly in the Appalachian region in the United States. Deposits near Farmville, Va., and Clover, S. C., have been worked for some years and are turning out many thousands of tons annually of this "domestic kyanite" for use in refractories and other ceramics.

The American kyanite has an approximate analysis as follows:

Alumina	57 to 60%
Silica	37 to 41%
Ferric Oxide	.5 to 1%
Titanium Oxide	1.20%
Alkalies	.5%

The pyrometric cone equivalent runs 36 to 38.

At about 1310°C, pure kyanite decomposes into mullite and silica with an accompanying increase of about 10% in volume and lowering of specific gravity to about 2.9. The effect of this volume change on the finished product depends largely on the grain size of the kyanite and upon the physical properties of the bond used.

Kyanite from India is different in character from American kyanite in that its native occurrence is as surface boulders sufficiently pure to use "as is," while domestic kyanite is always associated with quartz, from which it must be separated by a froth flotation process after grinding down to —35 mesh. In consequence, domestic kyanite is not offered in grain sizes larger than 35 mesh, while Indian can be calcined in lump form and used in any grain size desired. It is therefore in demand as these large grain sizes make an excellent grog.

Indian kyanite, however, must be purchased with great care as governmental changes over there in recent years seem to have had the effect of slackening the controls over quality. Although pure kyanite runs theoretically 63% Al_2O_3, good Indian kyanite will show 64% or even more due to the presence of free corundum in this ore.

Australian sources of kyanite have not been developed to any substantial extent and African, while resembling Indian in that the ore is fairly pure in its native state, has not been a serious competitor of Indian kyanite on account of its lower alumina content, its variability, and the softness of its lumps.

American kyanite is offered in raw form or calcined to mullite, and in grain sizes —35, —48, —100 and —200 mesh. While the mullite form is quite stable as to volume change under heat, the raw shows definite and substantial expansion, depending upon grain size and temperature. This property permits the use of raw kyanite as a balance against clay shrinkage in refractory bodies and it is therefore widely used in high-duty cements, ramming mixes and mortars. Domestic kyanite also goes into insulating brick, fire brick, kiln furniture, and all kinds of refractory shapes.

While American kyanite's first inroads into the clay products field took place in super-refractories owing its resistance to extreme temperatures, it is now making great headway in ceramic bodies not even subject to heat at all, after their original firing in course of manufacture. This is due to the well-known interlocking property of the mullite crystal which gives much added strength to all ceramic compositions, even when fired at low heats during manufacture. The result has been a rapidly increasing use of kyanite in sanitary porcelains, wall tile, precision casting molds, and many other lines.

Lead Oxide

Two types of lead oxide are used in ceramics, litharge or lead monoxide and red lead. Litharge, PbO has a mol. wt. of 223, sp. gr. of 9.3-9.5 and a melting point of 888°C. Insoluble in water but soluble in alkalies, certain acids and some chloride solutions. Red lead Pb_3O_4 has a mol. wt. of 686 and sp. gr. of 9-9.2 and it decomposes between 500° and 530°C. It is insoluble in water and is decomposed in some acids, leaving insoluble lead peroxide.

Lead and its oxides and other compounds are derived from the mineral galena which is mined in Kansas, Missouri, Idaho, Utah, Oklahoma, Mexico and foreign locations.

Lead has many advantages as a glaze ingredient, which results in its continued use in spite of the hazard to the worker. The superiority of lead glazes lies in their brilliance, lustre and smoothness, which are due to their lower fusion point and viscosity. Lead glazes are resistant to water solubility and chipping, and have few faults in texture and bond. They have high mobility, refractivity and elasticity, and are softer than leadless glazes. Lead glazes are said to be more "fool proof" in the plant, since errors in processing and composition affect the properties of the finished ware to a lesser degree.

All investigators agree that the use of fritted glazes, in which all of the lead is fritted, has important health advantages. In this way the raw lead is converted into relatively harmless lead silicates which are much less soluble in dilute acids or the gastric juices. Lead silicates are more slowly absorbed after entering the respiratory system, and can be eliminated with less lead absorption. Of the lead silicates, the bisilicate is much less soluble than the ortho-silicate or the mono-silicate. When dustless lead silicate is used in place of lead oxide, the lead hazard is practically nonexistent.

Lead Silicate

(Lead bisilicate or lead monosilicate.) Two types of fritted lead silicates are available for use in raw glazes, and enamels. (A) A 15% SiO_2, 85% PbO composition which is approximately the eutectic mixture of lead orthosilicate ($2PbO : SiO_2$) and lead metasilicate ($PbO : SiO_2$). It melts at 725°-775°, and is free from uncombined lead oxides and silica. This material is sometimes called lead mono-silicate. This is not strictly accurate since lead monosilicate would more properly refer to the lead metasilicate composition ($PbO : SiO_2$). It is used, however, to distinguish the basic lead silicate from lead bisilicate. (B) A composition of 65% PbO, 34% SiO_2 and 1% Al_2O_3. This material is commonly called lead bisilicate. Either of these materials offers a number of practical economies in plant production and allows the introduction of lead, with its consequent benefits, in an easily handled, dustless and safer form. The mechanical and volatilization losses of lead are thereby reduced to the minimum. The monosilicate can be used competitively from a cost standpoint to replace lead carbonate, red lead or litharge.

Lead Silicate, Hydrous

"$PbSiO_2$—$Pb(OH)_2$, mol. wt. 807, sp. gr. 5.8-6.5. This material has been put on the market as an alternate or replacement for basic carbonate white lead where the evolution of CO_2 from the carbonate is undesirable. It is a fine particle size powder of high purity and is prepared by milling and hydrating "lead monosilicate" under controlled conditions. It has been found useful as a mill base addition because of its freedom from gassing; good dispersion; and excellent suspension qualities.

A glaze can be made for sewer pipe using lead silicate and up to 40% of the native clay as a base in addition to other glaze constituents. This glaze, while more expensive than normal salt glazing, produces higher strengths and more attractive glazes.

Lepidolite

Commonly called "lithium mica," this compound is a lithium-potassium-aluminum fluorsilicate: $LiF : KF\ Al_2O_3 : 3SiO_2$. The theoretical lithia content is 6% plus but actual samples run about 4% due to partial alteration of the mineral and partial replacement of lithia by soda and potash. It is found chiefly in California, Colorado, South Dakota, New Mexico, Rhodesia and Southwest Africa.

Lepidolite may be used to brighten most glazes. It is added with flint at the expense of feldspar on a balanced alumina-silica ratio basis. High grade lepidolite is available in large quantities.

Lignin, Lignin Extract. (See Binders)

Lime

(Calcium oxide, whiting) CaO. Mol. wt. 56 and sp. gr. 3.4. Lime as CaO is not found in nature. Calcium carbonate, which is the chief source of lime, is found in the form of the mineral, calcite. Impure calcite occurs as rock limestone in large quantities in many parts of the world. Limestone may vary from pure calcium carbonate to pure dolomite, $CaMg(CO_3)_2$. Commercial lime may contain as high as 45% magnesia and such impurities as silica, iron oxide and alumina. Commercial limes are classified according to their relative content of CaO and MgO, as follows:

High calcium lime—less than 5% magnesia.
Magnesia lime—5-25% magnesia
Dolomitic lime—25-45% magnesia.

A lime carrying less than 5% total of silica, alumina iron and so forth is a rich lime. Use of the term lime, in ceramics, generally infers some ground limestone sold as whiting.

Limestone occurs in many parts of the world, some of the purest being found near St. Louis, Mo., and in Kentucky. As whiting, lime is found in England as a defined chalk, such as the chalk pits of Dover. As dolomite it is found in various parts of the world and in this country the best known deposits are in northern Ohio. Wollastonite is a form of calcium silicate and at times it is said to constitute the chief mineral of the rock mass. This type of limestone is found in California, in the Black Forest of Germany and in France.

A number of terms are in general use for the different varieties of limestone based on differences of origin, texture, composition and so forth. The more important are as follows:

Marble is a limestone which is more or less distinctly crystalline. A marl is a loosely cemented mass of lime carbonate with clay and usually found in lake basins. Oolitic limestones are so called because of their resemblance to a mass of fish roe and are made up of small rounded grains of pure lime carbonate. Chalk is a fine grained limestone composed of finely divided calcium carbonate from shells. Argillaceous limestones are those in which silica is present in combination with alumina.

It may be said, regardless of the impurities that are found in limestone, that lime is in all cases practically the only base found in a pure theoretical limestone. In the dolomitic lime the base is some value between magnesium and calcium in certain definite proportions very close to 56 of calcium carbonate and 44 of magnesium carbonate.

In a leadless type of matt glaze, calcium in combination with chrome stain produces a fine green. Calcium and zinc produce a pinkish to brownish shade, while calcium and barium produce a dark green. Calcium and magnesium produce a brownish shade, and calcium and lead produce a fine bright green.

In the regular type of bristol glaze with a low feldspar content, that is, lower than .4 equivalent, maximum glass is obtained when the ratio of CaO to ZnO is less than 1:1, while with high feldspar the ratio of calcium to zinc must be higher, that is, at least 3:1.

Lime is used in the production of silica brick. It is added either dry to the mixer or suspended in the water added to the batch. It acts to bond the nonplastic quartz grains together before firing and, more importantly, exerts an important influence on the conversion of quartz to the higher crystalline forms of silica.

The material, finely ground, can be added to red firing clays used for brick or tile. Used in this manner the effect of iron as a coloring agent can be minimized or overcome, resulting in a light pink or yellow and dirty buff. Flashing procedures will affect the final color. However, the safe firing range will be reduced at the same time and the maximum temperature that the ware will stand is also reduced. Over firing will result in sudden and catastrophic vitrification.

Lime in the form of nodules of any great size occurring in clays will seriously impair the economic utilization of that clay. Such stones, if burnt in the brick, will, when exposed to the air, hydrate* and the increase in size will fracture the exterior face of the unit. When occurring as a strata of limestone in a pit the entire strata can be picked out. Lime occurring as scattered stone in alluvial deposits can be removed with conical rolls if of large size and the smaller stones can be crushed to small sizes by running all of the material through smooth rolls. The harmful effects are minimized when the size of the lime is reduced.

Limestone. (See Lime)

Limonite

(Brown iron ore.) $2Fe_2O_3\ 3H_2O$. An impure hydrous ferric oxide; probably actually a group of substances of variable composition and colloidal in nature. Impurities are silica clay, manganese oxide and organic matter. The water content is colloidal rather than combined and, though variable, averages about 15%. Sp. gr. 3.4-4.0 and hardness 1.0-5.5. Limonite gives yellow and orange coloring to clays, though it is sometimes obscured by organic matter present. On heating to about 500°C, limonite is decomposed to red ferric oxide. Limonite automatically colors clay bodies in which it occurs. Occasionally the mineral is intentionally introduced to get iron oxide colors. Blue shale deposits often leach to a characteristic yellow on exposure to the elements and this color change is associated with the change of other iron compounds to limonite.

Litharge. (See Lead Oxide)

Magnesium Carbonate

Magnesite

(Magnesite) $MgCO_3$. The mineral magnesite has a sp. gr. of 2.9-3.1 and a hardness of 3.5-4.5. Chemically pure magnesium carbonate has a mol. wt. of 84.3 and sp. gr. of 3.0. It loses its carbon dioxide at 900°C, is slightly soluble in water and soluble in acids. Magnesite is quarried in Washington, California, Russia, Austria, Greece and Czechoslovakia. Magnesium carbonate is also produced from sea-water in California, on the Gulf Coast and recovered from brines in Michigan.

It is the major constituent of a group of refractory products, basic refractories, that are growing rapidly in importance and are used in cement kilns and the furnaces of the metal-producing industries. When used for this purpose, the magnesium carbonate is "dead burned" in rotary kilns to produce a hard dense pebble of varying size. This intermediate form is crushed and the particles graded to provide a mixture of particles according to a designed standard. The magnesium carbonate is then mixed with other ingredients including organic binders in batch mixers and brick are formed by the dry press method. Such brick are available as chemically bonded brick or as fired ware.

The chemically bonded brick are burned in service. An interesting phase of their production is the use of metal covers for a significant amount of them. Metal clad brick are reserved for areas of intense conditions. While more expensive than either clay or silica refractories, the added life and higher operation temperatures attainable with basic refractories seems to indicate the continued expansion of the use of this material. An important number of chrome-magnesite brick are being manufactured in which the magnesite is used with varying proportions of chrome ore.

In glazes, magnesium carbonate acts as a refractory up to a relatively high temperature when it becomes an active flux. The formation of magnesium silicate in glazes develops an elastic glaze and at the same time develops glazes with rather low coefficients of expansion. Very often magnesium carbonate is used to check the fluidity of a glaze. This is a desirable property when dealing with crystalline glazes. Magnesium carbonate also seems to improve adherence.

Magnesium Oxide

(Periclase). MgO. A synthetic mineral produced in electric arc furnaces or by sintering of amorphous powder. Specific gravity of pure crystal is 3.58 and Mohs hardness is 6-6.5.

Made in varying degrees of purity, depending on raw material. Both natural and synthetic magnesites are used with higher purity fused products dependent mainly on the latter.

Refractory applications consume a large quantity of fused MgO. Both bricks and shapes are fabricated at least partially of fused grain for use primarily in the metal processing industries. In this field lower purities (85-90%) are generally used although there is a tendency toward higher purity levels as the industry becomes aware of the effect impurities in the MgO can have on metal properties.

Heating Unit Insulation is another major application for periclase. High purity levels have always been important in this industry but types of impurities are of equal importance. For many years the industry standard was a product made from Indian magnesite (95%). Recently, however, the trend is toward higher purity and a synthetic magnesite (99.5%) is being used more and more. Some seawater magnesite is also used.

Principal advantage of periclase in this application are its thermal conductivity and electrical resistivity at elevated temperatures, its cubic crystal structure, its crushability during compaction, and its relatively low cost compared to other possible materials.

Specialty crucibles and shapes are also fabricated from fused MgO. These are used in pyrometallurgical and other purifying processes for special metals. Both slip casting and pressing techniques are employed to manufacture shapes.

Thermocouple insulation comprises still another outlet for periclase. Since most of these go into nuclear applications a high purity product is required. Both grain and preformed bushings are used to load the tubing. Densification is obtained by diameter reduction processes similar to those used in heating element manufacture.

Magnesium Sulfate

(Epsom Salts). $MgSO_4 \cdot 7H_2O$. Mol. wt. 246.5. Soluble in hot or cold water. Magnesium sulfate occurs as the mineral epsomite; it is found in British Columbia and in Washington, and is found in brines in Michigan. This material may also be produced by the action of sulfuric acid on magnesite, dolomite or other magnesium rocks.

The most important ceramic use of magnesium sulfate is for setting up enamels. The proper amount of magnesium sulfate enables an enamel to be used for a long time without balling up, and it prevents the enamel from running on a piece of ware. Too much of it produces a dull finish and possible crazing. Further, magnesium sulfate in the slip causes rust on any iron containers.

The effect of magnesium sulfate addition has been noted on dipping slips and in one case the use of 3 cc of magnesium sulfate per quart resulted in a heavy application with good draining.

When used to set up or thicken a glaze or slip, it must be used with caution as the ideal amount is quite critical. Besides reducing running of a glaze from a coated surface, it serves to increase the storage life.

Magnesium sulfate is one of the causes of "dryer house scum" appearing on structural ware. Clays containing small quantities accumulate a thin coating of the salt on the surface of the ware when the water of plasticity is evaporated in the drying process. During firing, the soluble salt is dissociated, the SO_3 being driven off into the atmosphere and the magnesium forming complicated calcium-magnesium-silica compounds that are insoluble and show as white or gray marks on the exposed parts of the brick.

Control of this type of scumming is usually done with barium carbonate which precipitates the soluble compounds to form insoluble compounds thus eliminating the migration of the scum causing material to the face of the brick during drying.

Other control methods used have included covering the face of brick with paper which was then burned off in firing and the reduction of the water of plasticity.

Magnesium sulfate can be added to clay to produce the characteristic white marks of "dryer house scum" if there is a market demand for such material. Application can be made with feeders or dosing each load of material as it is used. Amounts required to produce any degree of scumming vary with clay and the conditions but small additions on the order of fractions of 1% have proven sufficient in some cases.

Magnetite. (See Iron Oxide)

Manganese Oxide

MnO_2. Mol. wt. 87 and sp. gr. 5. It is converted into MnO at 535°C, is insoluble in water and nitric acid and soluble in hydrochloric acid. It occurs in nature as the black mineral, pyrolusite, which is mined in Russia, Gold Coast, India, South Africa and in small quantities in several of the United States, including Tennessee, Montana and Virginia.

Manganese dioxide is much used in the face brick industry to develop gray effects in the body of buff firing brick. When used as a body stain, effect depends on the grain size of the manganese as well as the amount used.

Mesh sizes of 20, 40 and 80 are often used for speckling effect while air-floated manganese develops uniform gray tones. When used in larger proportions, dead black brick can be produced. When used as an additive to red burning brick, the effect is to make a rich red color, depending on the amount used.

In larger grain sizes, manganese can be added to glaze to develop texture effects as well as large black spots contrasting with the color of the glaze. Some producers use fine manganese to break up the monotone of glazes. In this service it tends to mask slight imperfections which would otherwise detract from the appearance of the units and will perhaps lower the rejection rate at the sorting and grading station.

Used as a color constituent it can produce pinks and browns as well as purples, depending on its associated compounds. It is quite sensitive to minute changes in firing conditions.

Mica

A general term used for a large group of materials making up a major division of clay minerals. Generally regarded as impurities in finer clays and subject to removal by washing, illites or mica may in structural clays be the major clay-like mineral present. It has characteristic endothermic peaks by which the presence of the mineral can be determined.

More specifically mica is used for the material that splits into characteristic sheets of considerable size and is used in industry as insulators and dielectrics.

A form of considerable interest to the structural field and to refractories is vermiculite, a form of mica that on rapid heating expands 16 times accordian-fashion to form a light and inert material suitable for inclusion in lightweight structural bodies and as a grog in refractories or as an aggregate for the production of lightweight casting refractory concretes.

Molasses

A complex organic material derived from the refining of sugar from sugar cane. It has been used as a binder in the preparation of silica, magnesite and carbide refractories. In this use molasses has two effects. One is to increase the plasticity of the body during the forming operations reducing losses due to handling; when dry the body containing small additions exhibits much greater strengths and during firing the additive burns away without affecting the composition of the body.

Mullite

$3Al_2O_3 \cdot 2SiO_2$. Sp. gr. of 3.16. It occurs in nearly all fired ceramic products containing alumina and silica but is seldom introduced as such, except as

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calcined kyanite which is converted into mullite in calcination. Mullite is rare in nature, one locality being the Isle of Mull, Scotland, where argillaceous sediments have been fused by igneous intrusion. The compound was formerly thought to be synthetic sillimanite, which name still persists in some quarters. Mullite is very refractory, breaking up into corundum and liquid silica at 1,810°C.

In the manufacture of refractories, the desirable mullite is formed from the chemically similar minerals, andalusite, kyanite and dumortierite, which decompose into mullite and silica at Cone 13, Cone 12, and Cone 6, respectively. To break up sillimanite in the same way, Cone 20 is required.

Mullite bodies show a uniform rate of thermal expansion and are resistant to spalling and deformation under load. Their strength is due to the interlocking of long, needle-like crystals. Some authorities recently stated that to get long crystals there must be present impurities which will promote their growth, therefore a mullite body with short interlocking crystals is more stable at high temperatures.

Nepheline Syenite

A holocrystalline granular igneous rock made up of nepheline ($K_2O : 3Na_2O : 4Al_2O_3 : 9SiO_2$), potash feldspar (microcline), soda feldspar (albite), and such minor accessory minerals as mica, hornblende and magnetite. It is found in New Jersey, New Hampshire, Virginia, Montana, Canada, India, Russia. It resembles granite in texture but contains no free quartz. An analysis of the commercial ceramic nepheline syenite from Blue Mountain, Ontario, is:

Loss on ignition	.3%
SiO_2	60.0
Al_2O_3	23.2
Fe_2O_3	.06
CaO	.3
MgO	Tr.
Na_2O	11.1
K_2O	5.0

This analysis represents the commercial material after removal of iron. The iron content of the original rock is in the range of 2 or 3%.

First quality nepheline syenite starts to sinter at cone 08 and has a PCE of about cone 7. There is a eutectic between soda feldspar and nepheline which is a factor in the wide sintering range of nepheline syenite.

In the past decade, nepheline syenite has found some application in glazes for structural clay products, including facing tile, terra cotta, ceramic glazes for sewer pipe, etc. In low temperature glazes where fritting is not done, nepheline syenite is especially helpful in promoting the maturing of the glaze due to its relatively low fusability.

Some high iron grades of nepheline syenite have been used for making sand face brick, imparting a textured, granular, decorative effect to the brick's surface.

The nepheline syenite is usually mixed with coloring oxides and some sand. Its primary role is to form a fired bond between the sand grains in the coating and the body of the brick. It also acts as an "extender" for the expensive mineral oxides.

Work done by Everhart at the Ohio State University Engineering Experiment Station showed that additions of 2.5 to 5% of nepheline syenite to the clay as a body flux gave acceptable absorptions and fired strengths that are obtained at substantially lower temperatures without accompanying reductions at the upper firing limit. This, of course, results in longer maturing ranges. At the same firing temperature sizable reductions in absorptions and increases in strength are secured.

A paper presented by Wilson and Koenig of the Ohio State University Engineering Experiment Station at the 59th Annual Meeting of the American Ceramic Society, Dallas, Texas, May 1957, reported on the use of nepheline syenite tailings in sewer pipe bodies. Their report dealt with minus 30 Mesh tailings from the high intensity magnetic separators used in preparing first quality nepheline syenite for use in glass and whiteware production. These tailings contain 2 to 3% Fe_2O_3 and are ground to a point where approximately 99% passes a 200 Mesh sieve. The authors reported that when fired to cone 02 and above, the additions of ground nepheline syenite tailings to fire clay and shale bodies provided lower absorptions, improved flexural strengths and longer maturing ranges.

The thermal expansions of a fire clay and shale sewer pipe body were significantly increased by additions of ground tailings—the effect was greater at lower cones than at the higher cones. The ground tailings also helped to reduce the free quartz content in the bodies.

When firing below cone 02 the additions of ground nepheline tailings to the clay and shale bodies affected the unfired properties thus acting in the role of a refractory grog.

The authors further reported that the commercial production of sewer pipe using a body containing 5% of the ground tailings and firing to cone 3 has confirmed the laboratory results regarding the lower absorption and increased flexural strength derived from the addition. A large reduction also was noted in the number of cracked pipe when the tailings were used. The reduction in the number of cracked pipe, according to the authors, may possibly be related to several factors, namely:

a. A slightly lower drying shrinkage and resultant drying strains owing to the non-plastic addition.

b. A reduction in the amount of free quartz present in the body owing to the absence of free quartz in the nepheline syenite, and

c. A reduction in the amount of free quartz in the body introduced from shale or clays as a result of the solution of the quartz by the additive (nepheline syenite) during firing.

Ochre

Natural occurring stains which are for the most part hydrated ferric oxides mixed with clay and/or sand in varying amounts. They can be used as coloring agents for engobes or "sands" applied to face brick and have in the past been used to color the "salt" coat applied to ware that resists salt glazing. In this technique fine, 60 mesh or less clay prepared from the native clay is mixed with ochre and applied to the surface to "catch" the salt glaze.

When ochres carry much manganese they grade into the umbers.

Opacifiers

Opacifiers are those materials used in glaze to produce an appearance usually called opaque, although they really possess translucency rather than opacity. Originally tin was the major material used to opacify glazes but more recent techniques make use of compounds of zirconium and titanium which provide similar results at less cost.

Orthoclase

$K_2O : Al_2O_3 : 6\ SiO_2$. A potash feldspar useful when the total quantity of sodium must be limited. (See Feldspar.)

Petalite

Lithium-aluminum silicate has the formula $Li_2O : Al_2O_3 : 8SiO_2$ and a density of 2.4. It contains 77.0% SiO_2, 17.5% Al_2O_3, 4.3% Li_2O and 0.5% other alkalies.

Petalite can be added up to 45% in semi-fritted glazes, resulting in a clear bright texture maturing at cone 02 up to cone 5. Petalite is effective in clear and opaque raw single fire glazed to cone 12.

When natural petalite is heated above 1,000°C there is an irreversible crystallographic inversion into a solid solution of silica in beta spodumene. This unique structure has virtually zero thermal expansion and provides the basis for low expansion ceramic bodies of unexcelled heat shock resistance.

Within the lithia-alumina-silica system there exists a broad compositional area of low-to-zero thermal expansion. Negative expansions are encountered in certain area. Such bodies can, of course be synthesized from pure chemicals and a wide variety of expansion characteristics can thus be obtained.

Because of these behaviors, petalite can be added to refractory mixes to improve their resistance to thermal shock. Such additions lower the P.C.E. of the refractory body but result in much longer life of refractories subjected to repeated severe temperature changes. Other lithium bearing ores such as amblygonite and spodume can be used in the same manner.

Plaster of Paris

Calcined Gypsum, Calcium Sulfate.) $CaSO_4 : \frac{1}{2}H_2O$. A white, gray, or pinkish colored powder prepared by heating gypsum ($CaSO_4 : 2H_2O$) to remove three fourths of its water of crystallization. Available in various types of products having specific, controlled properties. When mixed with water and allowed to rehydrate to the dihydrate there is no apparent action at first, but soon a slight stiffening takes place and shortly after that it "sets" to a solid mass. As set progresses the mass begins to heat and expand, and final set is not reached until the evolution of heat has ceased and expansion is complete.

When suitably compounded with refractory substances, molds for the casting of non-ferrous alloy such as white metal, aluminum, brass are made with plaster. It is used in the manufacture of low density insulation and to provide green strength to mixtures of clay and non-clay refractories. In this use it can provide the set required to capture the frothy nature of lightweight refractories.

Much used by the manufacturers of finer ceramics for molds used in casting and jiggering processes, plaster of paris finds similar but less extensive use in the casting of complicated refractory shapes and for short run ramming molds.

Terra cotta shapes are formed in these ramming molds also and the same techniques can be used to make special brick shapes.

At elevated temperatures the sulphur is driven off and the material reacts as lime when used to bond bauxite, chrome or silica brick. In silica brick this is an important effect and the setting properties of the material enhance dry strength. The sulphur freed from the ware reacts with water to form sulphuric acid and is objectionable.

Polyester Resins

A class of transparent thermosetting resins derived from the reaction of unsaturated polybasic acids and polyhydric alcohols. These resins are used as bonding agents for fibrous glass products and for laminating. They require only contact or very low pressures for laminating, and have satisfied the demands for resins permitting lamination for large objects or irregular shapes.

Polyethylene

A water repellent, white, tough, leathery, thermoplastic resin very similar in appearance to paraffin wax. Properties vary from a viscous liquid at low molecular weights to a hard wax-like substance at high molecular weights. It is used as a coating for glass bottles and fibrous glass fabrics. Special treatments for glass are required to obtain good adhesion between polyethylene and glass. Also used as an injection molding material for ceramics.

Polyvinylacetate

A product of the reaction of acetylene and acetic acid in the presence of a catalyst. It

polymerizes to a linear thermoplastic resin. It is odorless, tasteless, nontoxic, slow burning, colorless, and has a reasonably low water absorption. Water emulsions if polyvinylacetate have extended the use of this resin. The resins are used extensively as adhesives for ceramic materials. These resins in a plasticized form are used in glass textile sizes to bond the individual filaments together.

Polyvinylchloride

A hard, flame resistant, and chemical resistant thermoplastic resin. The resin is available in the powder form, as a latex, or in the form of plastisol. Polyvinylchloride resin, pigments, and stabilizers are milled into plasticizers to form a viscous coating material (plastisol) which polymerizes into a tough elastic film when heated. Plastisols are used extensively for coating glass bottles and glass fabrics. See electronic and new ceramic section.

Potash

K_2O. Mol. wt. 94.2, sp. gr. 2.32, is very soluble in water and other solvents. The most important original source of commercial potash is natural potassium salts, which are mined in New Mexico, California, Germany, France and Russia. These are prepared as potassium nitrate and potassium carbonate for use in ceramics, but most of the potash is automatically introduced into batches in feldspar.

Its use, other than as a conditioner for clay, slips, engobes and as a glaze constituent, is in the elimination of green efflorescence on buff brick. If brick subject to green efflorescence caused by vanadium salts are treated with potash they will not develop the characteristic stains. A usual treating procedure involves dipping cubes of fired brick in a dilute solution of water and potash. When completely saturated, brick are removed and allowed to dry. The literature mentions a .4% solution although doubtless the proper amount will depend on total amount of soluble salts present in the brick and the absorption of the brick.

Potassium Carbonate

K_2CO_3. Commonly called pearl ash or potash. Mol. wt. 138. Although formerly imported, all domestic requirements at present are being supplied by American producers who distribute a product made from the electrolysis of potassium chloride from deposits located in California and New Mexico.

In this hydroxide or carbonate form, potash is an important deflocculating agent. It is used at ordinary temperatures to prepare casting slip, glaze slips, and engobes, to purify clay, to reduce the plasticity of excessively plastic clays, and to neutralize any acid present.

In glazes, potassium carbonate appears as an ingredient when it is desirable to modify the effect of a colorant such as copper oxide which may thus be brought through tints of green toward yellow. When potassium carbonate is used in colored glazes, it is advisable to frit about 90% of the clay but none of the color.

Pyrophyllite

$Al_2O_3 : 4SiO_2 : H_2O$. One of the rather large family of hydrous aluminum silicates. Often confused with talc, as the two minerals have almost identical physical properties. However, pyrophyllite is an aluminum silicate, whereas talc is a magnesium silicate. It is very soft, with hardness zetween 1 and 2 and specific gravity of 2.8 to 2.9. It is found in North Carolina, Pennsylvania, California and Newfoundland.

Used in varying proportions as a part of refractory units where the very low rates of thermal expansion and contraction tend to increase resistance to spalling and cracking. The major difficulty in its use is the lack of plasticity of the material and the resulting less to be expected in the forming operations.

Used in minor proportions in otherwise difficult clays it will increase or decrease the maturity temperature, depending on the impurities in the clays and pyrophyllite, and reduce shrinkage in firing. In glazed ware it is reported to reduce or eliminate crazing.

Rutile

TiO_2, Sp. Gr. 4.2-4.3 The mineral mined in several places in the United States and in several foreign countries is an important source for titanium oxide. However rutile contains 5% or sometimes less of various oxides of iron, chromium and vanadium. The material can be used to color clay products advantageously. Color developed depends on the mesh size of the rutile and the source, as varying amounts of impurities effect the results.

Granular rutile from Virginia will develop strong lavender colors and can be applied to stiff mud brick with sand blasting or as unground portions of engobe rolled, sprayed or poured on the column. Mesh sizes of 200 and 400 are available and will produce yellow and buff in small concentrations on the order of 10 to 15%, and larger additions to the sand will result in orange.

Used in the mold release sand for the production of soft mud brick, extraordinary colors will be produced. Lower temperature maturing ware might require some type of carrier to insure superior adherence of the rutile colorant to the face of the brick.

Sawdust

Purchased as mill byproduct in most cases, the purchaser is not able to always secure the type and kind best suited for the purpose he intends to use it for. Generally sawdust from soft woods will be larger in particle size than hard wood dust and usually not as suitable. Average weight of sawdust is 20 lbs. per cubic foot and is usually sold in units of 200 cubic feet.

Average moisture content ranges around 40% and when used as a component of structural or refractory products the heating value of the sawdust will reduce the amount of primary fuel required. One pound of sawdust will produce approximately 5,000 B.T.U. When particle size is important fines can be removed with air separating equipment and over size pieces or dust reduced to any desired size with grinders, crushers or hammer mills.

Sawdust can be used in the soft mud, the stiff mud and the dry press methods of making brick. Added in the pug mill or a mixer varying percentages of sawdust can be added as a method of reducing the weight of the product, increasing the drying rate and effecting economies in firing.

Used as early as 1885 in the U.S., sawdust and clay bodies were widely used in fireproofing tile production and was known as "terra cotta lumber." In some plants using a slop on the faces of the brick for architectural effect, sawdust is used on top of the slop or mud to prevent brick from sticking when they are "faced." In this use sawdust can be spread mechanically.

Sawdust can be added to fireclays and the resulting mix made into any standard refractory size and fired. The density of the resulting refractory can be controlled by the proportion of the clay and dust but the compressive strength suffers as the unit is made lighter. Service temperatures are controlled by the fireclay used. Some sawdust is improved by roasting before use which can be done in rotary ovens but the charring should not be done above 600-650°. This tends to reduce the amounts of volatile material released from the mix during firing and eliminates all of the water vapor.

Used in structural clay products, the sawdust reduces weight, improves insulating properties and when used in large percentages produces a unit so porous that it can be nailed and cut with steel tools.

Primarily used in refractories to produce insulating units, lighter mixes produce good "U" factors but at considerable sacrifice in compressive strengths.

Sericite

$K_2O \cdot 3Al_2O_3 \cdot 6SiO_2 \cdot 2H_2O$. A micaceous-type mineral with composition indicating that it probably originates from the alteration of feldspar. It occurs with some of the pyrophyllite deposits in North Carolina and is found in a relatively pure state in Wyoming. An analysis of unrefined material from near Wheatland, Wyo., is as follows:

Silica	51.80%
Alumina	35.60
Potash	6.75
Soda	1.46
Iron oxide	0.70
Lime	trace
Ignition loss	3.60
	99.91%

Although sericites, as such, have not yet been used in ceramic bodies, the use of a high (15%) sericite phrophylite has been tried in a number of whiteware compositions where it was found that the substitution of this material for flint materially increased the fired strength, probably caused by the formation of mullite with its resulting interlocking grain structure, due to the effect of heat on the sericite. The substitution has little or no effect on the shrinkage or absorption of the bodies.

Silica

Silica occurs in a number of crystal forms, the nature and stability ranges of which have been extensively studied. This study has been difficult, partly due to the slow rate at which the changes occur, and the low thermal conductivity of silica and silicates, which tends to mask the results and prevent precise determinations. Sosman regards the allotropic changes as partly structural and partly atomic; he regards the sluggish changes as being due to the rearrangements of the silicon and oxygen atoms, and the rapidly reversible changes as being due to changes in the relative positions of the electron orbits which unite the atoms.

While tridymite and cristobalite may exist for indefinite periods of time at room temperatures, the low temperature or alpha form of quartz is the only form of silica truly stable at these temperatures. A considerable expansion accompanies the conversion of alpha cristobalite to beta cristobalite in the temperature range of 220-275°C and a sudden expansion of about 1% occurs during the inversion of alpha quartz to beta quartz at 573°C. The inversion of quartz to tridymite at 870°C is accomplished by an expansion of about 15%. These abrupt volume changes cause strains in a body containing free silica.

In recent studies at Alfred University and their ceramic college, it has been found that the crystal changes of silica are considerably responsible for the cracking of brick and tile in the heating up and cooling stages. Temperature curves can be so arranged that brick with high free silica content can be taken through the dangerous periods slowly and evenly to prevent any cracking or straining in the body.

The same phenomenon occurs in cooling. If a brick is cooled too rapidly and is subjected to these silica strains, it will be cracked throughout the cooling. Such a brick must have a longer cooling period to allow the complete transformation of the crystal to the more stable form.

BRICK AND CLAY RECORD in discussing firing curves, both in the Hanley story, 1955, and the Kelsey-Ferguson story, 1956, pointed out that brick can be cooled rapidly and heated rapidly in those stages where silica inversions do not occur and if organic substances are fired out. In both of these operations firing curves are very rapid, time is rapid and production is very high from tunnel kilns. The curves are based on proper knowledge of the silica inversion point.

All forms of silica, when heated to sufficiently high temperatures fuse and form amorphous silica glass or fused silica. If the heating is very rapid, quartz may fuse without appearing to pass through the intermediate stages. When fused silica is very slowly cooled, the reactions taking place are the reverse of those occurring during heating and alpha quartz will ultimately be produced.

Very successful refractories have been made by adding fused silica to the body. Quartz in itself, after it is fused, has a very low coefficient of expansion and actually assists in bringing out a good heat resistant type of body. There is a danger of recrystallization of quartz if reheated too high and too many times, which of course would destroy the low coefficient of expansion.

Silica refractories are made from gannister and quartz rock. These refractories are very commonly used in roofs of glass tanks and open hearths.

The rock is brought into the plant and ground up to a definite range of mesh. The silica then is mixed with a binder, sometimes even molasses, and then shaped into form either by dry pressing or by drop press. Silica is fired to approximately 2700° for the final formation.

Lime is sometimes used as the binder and acts as a flux too.

Two types of silica refractories are made, one of the ordinary variety and the second with very low content of alumina as a contaminating mineral. Alumina up to possibly 4% acts as a flux, bringing down the service temperature of the pure silica brick.

In some heavy clay products plants where clays are gummy and very fine grained, silica is added to open up the clay body.

Clay Modifiers

Silica is used in all glazes as the chief, and often the only, acid radical (RO_2 group). It may be adjusted to regulate the melting temperature of the glaze. In common glazes, the ratio of silica to bases (RO group) is never less than 1:1 nor more than 3:1. By varying the relative proportions of the RO group and balancing the group against any desired silica content, the maturing temperature of a glaze may be quite closely controlled. In other words, the fusability of the glazes used in the presence of equal proportions of fluxes depends on their relative silica contents.

Silicones

A series of polysiloxane compounds, the structure of which has alternating silicone and oxygen atoms (Si-O-Si-). The structure is comparable to that of a carbon chain and, as in organic chemistry, the length of the chain and the degree of crosslinking determine the form of the silicone. Chains are longer and crosslinking is introduced and increased as the form moves from a fluid to a rubber to a resin.

The silicon atom has an atomic number of 14 and as such is normally tetravalent. The bonds which are not tied up in the polymeric network can be used to link organic components, the size and nature of which contribute greatly to the properties of the silicone.

The first step in the production of a silicone is the reduction of silica, SiO_2, elemental silicon by reduction with carbon in an electric furnace. The silicon is then reacted with organo chlorides to form organo-chlorosilane, which is hydrolyzed and polymerized to the desired material.

One of the outstanding properties exhibited by these unusual materials is a high water repellency which has been used for several years to waterproof existing walls and other porous structures. When walls are treated with silicones, they are still permeable to water vapor allowing any trapped water to move from the wall by evaporation and equalizing vapor pressures on both sides of the water repellent.

A technique of applying the silicones to individual brick has been developed which offers outstanding advantages to a large group of face brick manufacturers. By eliminating water migration through the brick, efflorescence from any source, (brick, mortar, water or nearby concrete), can be eliminated and the finished wall will further resist air and water borne soil much longer than an untreated wall. As water is the major disruptive force, walls kept dry in this manner will resist spalling, and crumbling due to freezing.

Two methods have been developed to apply the silicone, spraying and dipping. The concentration of active silicone in the carrier must be worked out for each application.

Sillimanite

$Al_2O_3 : SiO_2$. This mineral, having the same chemical composition as andalusite and kyanite, is often confused with them. There are important differences in properties. Sillimanite has a specific gravity of 3.23 as compared with 3.16 for andalusite and 3.60 for kyanite. Both andalusite and sillimanite crystallize are in orthohombic form, while kyanite has a triclinic structure. Sillimanite has a hardness of 6-7, andalusite has 7.5, while kyanite varies from 4 to 7.

Upon heating, sillimanite decomposes into mullite and silica, but not until the temperature reaches 1545°C. On further heating to 1810°C the material breaks up into corundum and glass.

Soda Ash

(Sodium Carbonate, Sal Soda.) This salt has the basic composition Na_2CO_3 with mol. wt. 106, specific gravity 2.53 and melting point 851°C. However, it may also appear as $Na_2CO_3 : H_2O$ (crystal carbonate) or $Na_2CO_3 : 10\ H_2O$ (sal soda). Soda ash has a theoretical solubility of 45.5 grams / 100 ml at 100°C but only 7.1 grams / 100 ml at 0°C.

Most soda ash is made by the Solvay process although a certain amount is prepared from lake brines and by electrolytic methods. "Commercial" grades of soda ash are available as 48% (Na_2O) light and dense and as 58% light and dense. Light and dense refer to apparent bulk density. Ordinary 48 to 58% grades are available in either light or dense but contain NaCl which may affect certain ceramic uses.

Soda ash is an active flux in ceramic glazes but can be used only as a frit ingredient because of its solubility. Na_2O added as soda ash in glaze frits supplements Na_2O from borax and feldspar components.

The deflocculating effect of soda ash in glaze frits supplements Na_2O from borax and feldspar components.

The deflocculating effect of soda ash upon clay-water systems is an important phenomenon in several branches of ceramic body preparation.

In the presence of small quantities of soda ash the water of plasticity of bodies will be greatly reduced with consequent improvement in workability, greater green and dry strength and less cracking. This is particularly true where strongly flocculant ions such as Ca^{++} or SO_4^{--} appear in the clay. High lime structural clay bodies are one example.

In this use they can be added in the pugging water or dry with accurate mechanical feeders to the clay any time prior to its delivery to the pugger. Fractions of 1% are usually all that is required.

In addition to the improvement of working properties of these types of raw materials the color of the fired ware is affected, usually to make stronger and more marketable shades.

Soda ash will react with massive lignite in certain ball clays to produce a very soluble and highly effective organic dispersing agent. Sodium silicate reacts much less strongly with massive organic inclusions so that under some circumstances soda ash is a far more effective deflocculant than sodium silicates. Normally, where lignite is low or absent, sodium silicate makes for lower viscosity than soda ash. Frequently, the two will be used in combination in a ratio suited to the type of deflocculation required.

Sodium Chloride

(Common Salt.) NaCl. Available in many qualities, bagged or in bulk. In most plant uses, lower qualities are quite satisfactory. Can be used as a bleaching agent in slips and glazes where it overcomes the effect of small quantities of iron oxide.

It is used in large quantities to glaze sewer pipe and, to a lesser degree, brick and tile. Not all clays are suitable for salt glazing. Barringer has reported that clay with a 3 to 8 silica to alumina ratio will salt glaze if sufficient temperature can be developed. The glaze itself seems to be 20% alumina, 54% silica with the balance being soda and other oxides.

In practice salt is applied as a vapor, created by throwing salt into the fire boxes of a periodic kiln after the kiln has reached a high heat. The salt vapor is carried into the ware area and condenses on all surfaces that it touches. In periodic practice, salting is repeated several times, the exact number of times is determined for each plant by experiment. As salting reduces the temperature quite rapidly the heat must be built up between saltings.

Salt vapor has a drastic effect on many refractory brick causing rapid failure mostly by dissolving the refractory. Insulating fire brick, by slowing condensation, delays this process. The amount of salt used varies widely with different clays, but generally 5-10 lbs. of salt per ton of ware seems to be sufficient.

Tunnel kilns can be salted, with salt vapors produced continuously in dutch ovens and pulled into the salting section of the kiln with a separate salt vapor exhaust system. Some plants inject salt into the salting section as a saturated water solution. In this installation, the volume change of the water vapor tends to build up a pulsating pressure in the section as the solution is added intermittently.

The salting temperatures of ware varies from cone 02 to cone 7 with the lower temperatures causing some difficulties. Salt glazing can be promoted by using a reducing atmosphere immediately preceding salting or by coating the ware with a "salt" coat which consists of finely ground clay applied to the face of the ware and which reacts more readily with the salt vapors.

Salt glazes are usually under tension which leads to crazing, lower pipe strengths and is not desirable. Additions of borax up to 10% reduce the tension and the defects resulting from it but does not eliminate them.

Under slips can be used in salt glazing and the color oxides can be mixed with the salt to develop glazes depend on the color of the body and firing conditions during firing, salting and cooling. They are colors not normally seen. The natural colors of salt range from clear to black.

Sodium Pyrophosphate, Tetra

$Na_4P_2O_7$. A prepared chemical, containing no water of crystallization, available in granular and finely powdered forms. It dissolves in hot or cold water and is mildly alkaline in solution. It has a pH of 9.1 to 10.3. It is an efficient suspending and dispersing agent for grease, dirt, clay and other insoluble materials, which leads to its use in the ceramic industry. In clay slips the material is used as a dispersing and thinning agent. Approximately 1¾ lbs. are used to disperse a ton of clay.

It is used as a deflocculant in glazes and in the purification of clays. It is also used as a means of removing iron from clays by washing. It is an efficient water conditioning agent and as such may be used when the effect of hard water produces undesirable results.

Sodium Silicate

$Na_2O : x\ SiO_2$.) A consideration of sodium silicate in the ceramic industry must be predicated on an understanding of what is meant by the term sodium silicate. In a commercial sense, sodium silicate is no more definite a term than clay. Its connotation is generic rather than specific. Attention must be called to this fact because in spite of voluminous literature there are still many technical men who think of a definite sodium silicate when they see the syrupy liquid of commerce.

Sodium silicates are made by melting sand and soda ash in a reverberatory furnace. Various proportions of the two ingredients are used and widely divergent characteristics result. The most alkaline liquid silicate made by this furnace process has a ratio of $1 Na_2O$ to 1.6 SiO_2 and the most siliceous liquid grade has a ratio of 1 Na_2O to 3.75 SiO_2. There are more alkaline sodium silicates made which are detergents and are known as metasilicate, sesquisilicate and orthosilicate.

The melted sand and soda ash coming from the furnace may be put immediately into solution. The most siliceous grade cannot be concentrated beyond about 32% total solids without going to a gel, but the most alkaline liquid can be concentrated to about 61% solids and still remain fluid. Instead of forming solutions, the melt may be a cooled to a glass which can only be dissolved in high pressure steam.

Because of the many grades of silicate and the great differences in their characteristics, it is evident that the proper selection is of importance to obtaining good results, and the manufacturers are usually well equipped to give technical advice which will enable the user to obtain best results with a minimum of energy.

Sometimes for reasons of economy and many times for reasons of better workability or improved finished product, sodium silicates are used as additives in various clay products and refractories. The sodium silicates, liquid and powder, are beneficial in varied applications such as in casting slips, clay mining, refining and treating, bricks, enamelware and glazes, Faience tile, roofing granules and refractory cements.

In processing raw clays the deflocculating action of sodium silicate is used to separate impurities such as quartz, feldspar, mica, and iron oxide. One to four pounds of silicate per ton disperses the clay and permits the heavy impurities to settle out. The ore suspensions of deflocculated clay can be pumped to settling basins more economically than by other means of transportation.

Powdered metasilicate is added to the finished clay as a dispersant for the convenience of users.

Sodium silicate acts as a dispersing agent in clay suspensions to produce high fluidity and minimum water content. 0.1% of sodium silicate converts a stiff clay mud into a thin liquid which can be poured or pumped without difficulty. The reduction in water content of a cast slip results in a shorter firing time, less shrinkage or warpage of the finished ware, and greater strength.

Light weight insulating bricks are made from vermiculite or perlite by bonding with sodium silicate and calcium carbonate or similar reactants.

Silicates serve as a source of silica in porcelain and glaze formulation. Since the silica has been fused with alkali, its use permits a reduction in the temperature required for fritting.

Silicates are used in Faience glazes to give artistic effects such as "crackle" or a fine crack design.

Silicates provide bonding strength at room temperatures. Powdered silicates are used in the dry clay type bonding mortars to be mixed with water just before use. Liquids are used with plastic chrome ore and other agents to formulate various types of furnace cements. Dry hydrated silicates are used with chrome ore formulations for gunning mixes to be used in patching while furnaces are under heat. Silicates provide temporary tack until the fusion effect of the other ingredients comes into play. They give greater green strength and greater fired strength in air set refractory specialties.

Sodium silicates are available in ranges from $Na_2O : 3.75SiO_2$ to $2Na_2O : SiO_2$. Liquids range from 35.0° Baume to 67.5° Baume.

Starch

A group of carbohydrates or poly saccharides occurring in many plant cells. It is available in the form of a white soft amorphous powder. It is derived from several vegetable sources, corn being one of the more important. It finds use in structural and refractory products as a binder. (See Binders.)

Steatite

An hydrous magnesium silicate, being a massive variety of talc. Specific gravity and hardness are the same as for foliated talc. Steatite contains only about 3.75 to 4.75% combined water, so that firing shrinkage of the mineral is only about 4%. Therefore articles can be machined of crude steatite nuggets which are much more exact in dimensions than those made of porcelain mixes which have a greater firing shrinkage. The natural mineral may be machined to close tolerances to make ware from mined blocks, or it may be crushed into a powder and dry-pressed using a small amount of binder.

Sulfur

S. An element with atomic weight of 2.06, insoluble in water but soluble in a number of organic reagents. It is mined as native sulfur in Texas and Louisiana and Mexico as well as the volcanic regions of Italy, Japan and Chile.

Its compounds are sources of many difficulties to the structural and refractory manufacturer. Major trouble makers are iron sulfate or pyrites, magnesium sulfate and calcium sulfate. Materials containing these compounds evolve sulfur dioxide during firing and the gas combines with water to form sulfuric acid which destroys equipment and building. The balance of the compounds tend to mar the appearance and usefulness of the product in which they occur.

Talc

A hydrous magnesium silicate considered to have the formula $3MgO \cdot 4SiO_2 \cdot H_2O$, although some talcs analyze almost $4MgO \cdot 5SiO_2 \cdot H_2O$. It is very soft, being used as the standard of No. 1 hardness in Moh's scale. Mineral masses of the composition are known as talc, the impure varieties as soapstone. Relatively pure massive varieties are known as steatite. The mineral is white, greenish-white, or light green and has a specific gravity of 2.6 to 2.8. It is found in Texas, Maine, Vermont, Massachusetts, Rhode Island, N. Y., N. J., Pennsylvania, Maryland, North Carolina, Virginia, California, Montana and Alabama; foreign deposits are in France, Austria, Switzerland, England, Bavaria, Italy, India, South Africa, Russia and Manchukuo. In the following table, talc A is from New York, B from California and C from Manchukuo:

	A	B	C
Magnesia	30.7%	30.5%	32.54%
Calcia	6.2	1.6	.20
Silica	55.9	59.7	51.00
R_2O_3	1.3	1.2	8.60
Ignition loss	5.9	7.0	7.30
	100.0%	100.0%	99.64%

High alumina talc is used more in more refractory, low thermal expansion bodies, making it unnecessary to add alumina to a body containing such a grade of talc. Usually just a clay-talc mixture will give the proper $MgO\text{-}Al_2O_3\text{-}SiO_2$ ratio when high alumina talc is used. The presence of alumina assists the development of cordierite.

The advantages of talc in ceramic bodies may be outlined as follows: (1) It is a cheap source of MgO which acts as a flux. (2) It imparts to a high-thermal shock, high electrical resistance at elevated temperatures, and low dielectric loss and low power factor. The latter two properties prevent that development when high frequency currents are applied which is of great importance in the insulation of electrical currents used in radio apparatus. The thermal shock resistance is due to the development of cordierite and mullite which have low thermal expansion. (3) It has a high specific heat and high resistance to acid attack. (4) In low-temperature bodies it increases thermal expansion. (5) In both high-and low-temperature bodies, it decreases moisture expansion.

Tar

(Asphalt, pitch.) A complicated and variable material derived from petroleum as an end product of the distillation process. Tar has several uses in the refractory, brick and sewer pipe industries.

Its major refractory use is as a bonding agent in the production of carbon brick. In this use, the refractory mix must be heated to a point where the tar can be uniformly mixed and then the brick can be pressed in the usual manner. Patents and published material also illustrate some uses as a bonding agent for basic brick and in some cases silica brick. Carbon brick are often laid with a mastic type mortar containing tar. Tar is used as a convenient source of carbon in the "flashing" of periodic kilns.

When thrown into the fire boxes, dense clouds of black smoke are formed and it is likely that colloidal carbon particles are actually taken up into the surface of the brick.

In any event, the colors developed in this type of reducing atmosphere are different than when "flashing" is done without the use of tar. Salt added with the tar also affects the results, sometimes adding luster to the brick.

In the sewer pipe industry, tar is used as a joint material. Rings of tar on the bell and spigot ends are formed in the plant with metal molds. When used, the tar ring is washed with a solvent and the ends pushed together. The joint formed is not elastic but in non-severe use has proven to be satisfactory.

Terra Sigillata

A coating material prepared by decanting ground clay to retain only the smallest clay fractions. Clays so altered can be sprayed, rolled or dipped onto bodies of the same clay or from clay of different origin. On firing, the ultra fine terra sigillata forms a glassy phase at lower temperatures than the same clay of more usual particle size. Clay can be chosen for particular colors or for light firing material can be tinted with common colorants. When using terra sigillata on bodies prepared from the same clay, physical fit is assured and adherence is good.

Clay containing illite and kaolinite are best suited to produce terra sigillata material. The montmorillonites are not suitable.

Umber

An iron oxide coloring material containing significant portions of manganese. It is temperature sensitive and develops browns and blacks. (See Ochre.)

Vanadium Oxide

In special refractories, vanadium tetra oxide forms a number of refractory combinations with fusion temperature above 1540°C. V_2O_4. Tends to be unstable in air and V_2O_5 the resulting form has a marked reduction in refractoriness.

Vanadium can be used in glazes as a tinting color.

Salts of the metal have been blamed for the green efflorescence that sometimes appears on light colored brick. Control is difficult though some producers find dosing raw clay with fluorspar reduces or eliminates the problem. Others find treatment of fired brick with potash solutions inhibited the appearance of the green stains. Recent developments of plant applied silicone formulations to fired brick appear to be one economical way to control the migration of the salts.

Vermiculite

$(OH)_2\ (MgFe)_3\ (SiAlFe)_4\ O_{10}4H_2O$. A peculiar type of mica that when heat treated expands 16 to 20 times its original size. The expansion is in one dimension much like an accordian. It is inert and is fairly refractory. Used as a grog in clays it reduces tendencies toward lamination and, being slick, acts as a lubricant for auger and dies.

Being resistant to fairly high temperatures it can be used as a grog for light weight refractory brick or as an aggregate for cast refractories.

The material occurs in South Carolina and Montana. It is shipped unexpanded after mining and sizing with the expanding being done near centers of use.

Volcanic Ash

(Volcanic dust, pumicite.) Volcanic glass blown into the air during the eruption of explosive types of volcanoes and deposited hundreds of miles from the source. The chemical composition of volcanic ash is similar to that of granite or rhyolite, but the rapid cooling of the material prevented the formation of minerals. This material occurs as a loosely consolidated gritty powder ranging in color from white to light gray. Deposits vary greatly in thickness and extent. The larger deposits contain reserves in excess of 100,000 tons and range in thickness up to 30 feet. Volcanic ash occurs in commercial quantities in Kansas, Nebraska, Oklahoma, Texas, Colorado, Idaho, Montana, Oregon, California and in British Columbia and Saskatchewan in Canada.

Volcanic ash is a naturally pulverulent material. Screen analyses of 70 samples from widely distributed areas in Kansas indicate that only 1 to 5% is retained on a 100 mesh screen and from 75 to 90% passes a 200 mesh screen. The pyrometric cone equivalent of Kansas, Oklahoma and Nebraska ash ranges from Cone 04 to 4, and this probably applies to volcanic ash in general, although one sample from Montana had a P.C.E. of Cone 8.

Its use in glazes is limited by the color change caused by the iron content but it finds use as an addition to clay bodies.

The use of volcanic ash in some types of sewer pipe bodies is advantageous because the low cost material permits vitrification over a wider range and imparts toughness to the finished product. The optimum percentage that should be used in a ceramic body of any type seems to be in excess of 7% but not more than 25%.

It lowers the maturing temperature of brick in the same manner and has been investigated as a ceramic bond in the production of lightweight aggregate clay block. Being extremely plentiful, the cost is attractive in areas where deposits are located.

Work indicates that the material can be expanded. A unique method reported indicates that the material can be mixed with the air of combustion and carried by that medium into the flame through an aspirating natural gas burner.

Whiting

Calcium carbonate prepared from certain sources. Originally from chalk cliffs in England, France and Belgium and then domestically from marbles or calcites. The term is being widened in use to include any fine calcium carbonate.

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Witherite. Native barium carbonate. (See Barium Carbonate)

Zinc Oxide

The use of zinc oxide in the heavy clay industry is in glazes. In glazes for brick, sewer pipe, tile, etc., zinc oxide serves in several different capacities, all of which are beneficial in developing high-quality products. Dependent upon the glaze formulation, the firing procedure, and the characteristics of the body, zinc oxide plays an important role in developing different properties in a fired glaze.

Zinc oxide is used to reduce the coefficient of expansion of the glaze, thereby helping to make the glaze "fit" the body. Crazing of the glaze may thus be eliminated. It improves the elasticity of the glaze, thereby improving its resistance to mechanical and thermal shock. Because of its fluxing action and broadening of the maturing range, zinc oxide in glazes in proper amounts improves the gloss.

However, in larger amounts, in a properly formulated glaze, zinc oxide is used to develop various textured glazes such as matte, eggshell, or crystalline. Certain colors are developed or enhanced by zinc oxide, and it also functions as a secondary opacifier.

The last property to be mentioned is that zinc oxide helps to make a glaze highly insoluble. This is particularly important for heavy clay products. Insolubility of a glaze coupled with crazing control are to be considered as extremely important properties in a glaze applied to heavy clay products, whether they are used inside, outside, or underground.

Wollastonite

$CaSiO_3$, Sp. Gr. 2.9, 4.5 hardness on the Moh's scale and P.C.E. of cone 18. This is a naturally occurring silicate which has been used in comparatively large quantities in ceramic tile bodies, glazes and electrical ceramics. Recently it has been reported that the addition of as little as 1-3% to typical structural clay bodies results in improvements of forming, drying, firing and quality of finished ware.

The Wollastonite particle is needle-like and it is thought that a jackstraw effect tends to open the clay body to allow the escape of water vapor during drying and the early part of the firing cycle. During the later stages of firing the same effect is observed on the products of ignition.

The material can be added with an accurate dry feeder to the pug mill.

According to a paper written by Jackson and Vukovich, additions of 1-3% Wollastonite increased dry strength of structural clays up to 40% and in laboratory firing of test bars allowed the firing rate between 900-1100° F. to be more than doubled.

A reduction in moisture expansion of autoclaved test bars containing Wollastonite was noted and this reduction ranged from 30% of the untreated value for minimum addition to 66% for additions of 3% to one o the clays tested. This effect would be expected to reduce delayed crazing of glazed structural tile after long periods of service.

Zinc

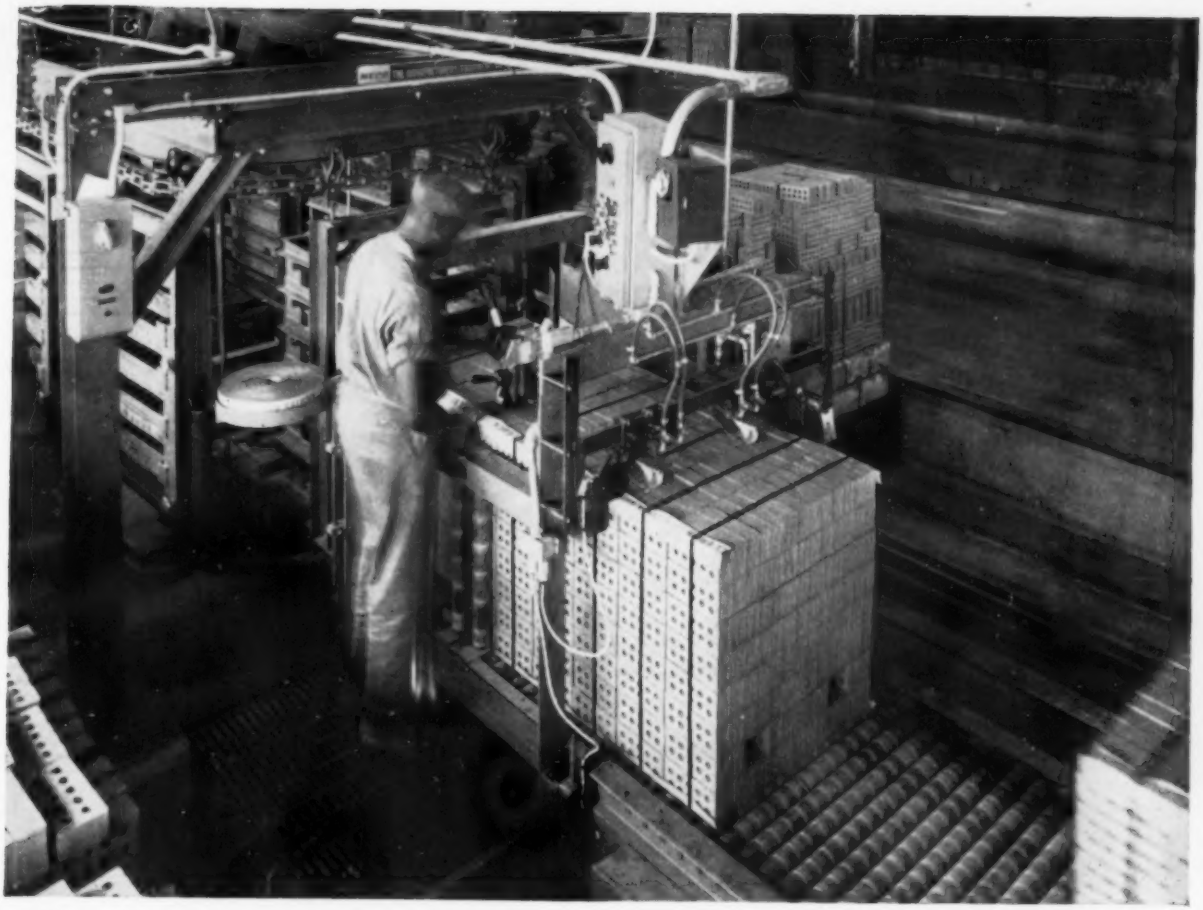
Zinc metal is used for flashing colors directly onto the body of the clay ware. The only use it is put to in the heavy clay industry is in the development of "flashed" colors on building brick. A mottled arrangement of colors ranging from dark brown to a dull green to a sort-of-yellow can be developed by exposing the brick, during the firing cycle, to the action of zinc vapor. This can be affected by adding mossy zinc to the fire box where it is vaporized.

Zirconium Oxide

Mol. wt. 123 and sp. gr. 5.7. It melts at 2700°C and has a low thermal conductivity.

To prepare useful products from zirconium oxide, stabilizing agents such as lime or magnesia must be added to the zirconia, preferably during fusion, to convert the zirconia to the cubic form. Most commercial stabilized zirconia powders or products contain calcium oxide as the stabilizing agent. The "stabilized" cubic form of zirconia undergoes no inversion during heating and cooling.

Stabilized zirconia refractories are used where extremely high temperatures are required. The low thermal conductivity insures low heat losses, and the high melting point permits stabilized zirconia refractories to be used continuously or intermittently at temperatures above 4000°F in neutral or oxidizing atmospheres. Above 3000°F in contact with carbon, zirconia is converted to zirconium carbide.



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Determine Firing Schedule of

It is possible to expand partially within a ceramic block during firing both the refractory and bonding phase. Cost savings can be realized by understanding and applying certain principles, but problems not common to current brickyard practices may be encountered. In this fourth of a series, Mr. Moffitt offers to the industry more challenging and rewarding possibilities inherent in ceramic block production.

By ROY B. MOFFITT

North Carolina State College
Raleigh, N. C.

Introduction. Heavyweight aggregate has been discussed in a previous paper as a possible raw material for the manufacture of a ceramic block which would possess the same or similar geometry of that of concrete block. It also has been emphasized in previous papers that since a ceramic block has to be fired, only certain raw materials could be used, whereas the concrete block competition was not troubled by this restricted selection of raw materials. However, within a concrete block it is the continued hydration of the portland cement that results in an undesirable permanent volume change, whereas a ceramic block by nature is not concerned with this problem.

It is the firing of a ceramic body that imparts to the resulting ware physical properties of a desirable nature. In addition, the heat that is used to fire the kiln can also be used to expand partially within a ceramic block, previously unexpanded, expansible particles. This concept can be divided into two categories: (1) expansion of the bonding phase aggregate of the ceramic block, and (2) expansion of the refractory phase aggregate of the composition. Of course it is also possible so to formulate a ceramic block composition in which both the refractory and binder phase aggregate portion will expand upon firing. However, for practical purposes this is not necessary for normal commercial application.

In the author's previous papers, *Ceramic Block or Clay Bonded Block?* and *Raw Material Cost of Ceramic Building Blocks*, there was considerable discussion of the two aggregate phases of a ceramic block composition. This discussion involved the relative P.C.E. (Pyrometric Cone Equivalent) requirements of these two phases and the preferred amount of each phase in the formulation.

Two Phases

A brief review of the basic concept of ceramic block formulating would involve the embodiment of two fundamental phases within the composition, the refractory and bonding phases. The refractory phase has a P.C.E. that is a minimum of eight cones more refractory than the bonding phase, and it preferably comprises 5/9 of the entire composition. The bonding phase preferably comprises 3/9 of the composition, and it is this phase that predetermines the firing schedule.

This schedule is to be so designed that the cone achieved by the kiln is substantially the P.C.E. of the bonding phase aggregate. The water which is subsequently added to the dry aggregate mixture (both bonding and refractory phase) is approximately 1/9 by volume of the composition. A dry strength binder is dispersed or dissolved, as the case may be, in the water to insure optimum distribution of the dry strength binder throughout the entire mixture. This dry strength binder, usually a liquid lignin sulfonic with special additives, is a minimum of ¼% by weight of the gross components of the composition (aggregate, water, and dry strength binder). If the ware is dried to 1% moisture content or below the dry strength binder normally imparts adequate dry strength to the ware for most requirements which may be demanded in the employment of mass production techniques.

Expansion of Bonding Phase Aggregate. In normal lightweight aggregate manufacturing procedures, there are two reactions within the expanding particle that take place at the same time, glass formation and evolution of gases. The firing schedule of a ceramic block is so designed that the approximate P.C.E. of the binder phase aggregate is achieved: hence, this glass formation during firing suggests that some degree of expansion is conceivable if expansible unweathered shale particles were to be used as the bonding phase aggregate of a ceramic block composition.

Nature of the Process. By the use of unweathered, expansible shale in a typical particle size distribution (shown in Table I) as the bonding

Table II—Typical Ceramic Body Composition

Material	*Parts by Volume*	*Tyler Standard Particle Size*	*P.C.E.*	*Unit Weight ASTM C29-42*
Lightweight Aggregate	3	—8 Mesh	14	71 lbs/ft³
Brick Grog	1	—8 Mesh	15	85 lbs/ft³
Weathered Sericite Phyllite	1	—8 Mesh	12-13	88 lbs/ft³
Unweathered, Expansible Shale	2	—8 Mesh	5-6	98 lbs/ft³
Water	1			62.4 lbs/ft³

Liquid lignin sulfonic organic binder ¼% by weight of gross components

phase of a ceramic body composition, and by the subsequent control of the firing schedule of a porous ceramic body formed from a composition which contained this material, the unweathered, expansible, shale particles will partially expand. Simultaneously with this expansion a ceramic bond is formed with other surrounding particles without any disfigurement of the fired product. The bloating of the expansible, unweathered shale is in opposition to firing shrinkage normally encountered in most ceramic bodies during firing.

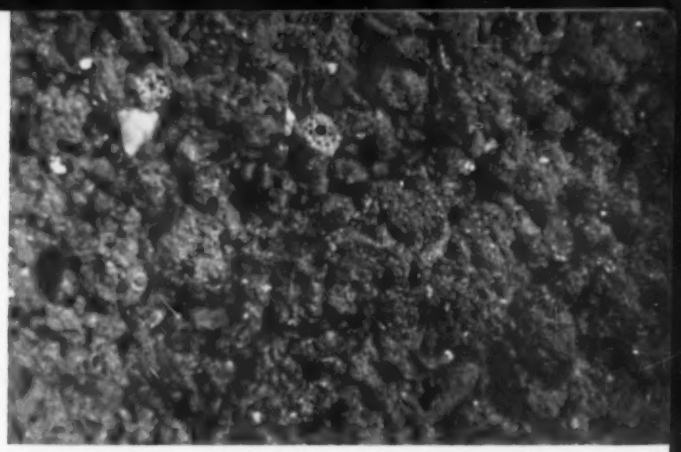


Fig. 1

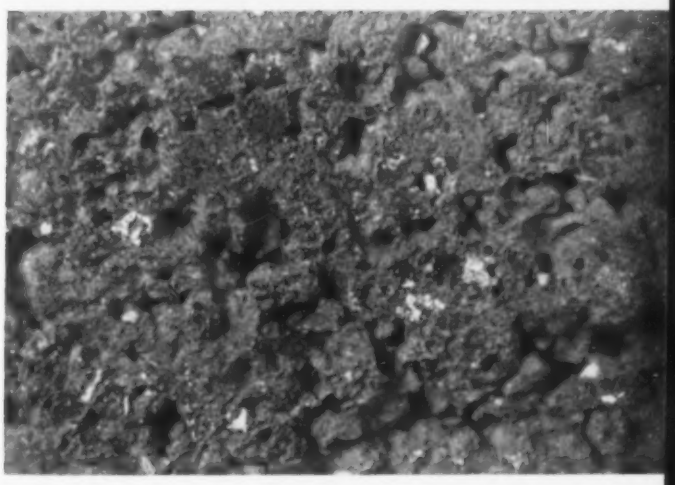


Fig. 2

Reduce Firing Shrinkage

Consequently, this partial bloating of the unweathered, expansible shale within a piece of porous ware (ceramic block) helps to reduce the inherent firing shrinkage as well as the initial weight and absorption of the fired body. In addition, the glass formation necessary for the expansion of the unweathered expansible shale, results in a ceramic bond between the surrounding particles simultaneous with the bloating of the particles.

Prior Art. In the work discussed in the previous paper the initial step always consisted of the expansion of various expansible shales by the application of heat. The second step was the use of the bloated particles as a specific part (bonding phase) of a ceramic body composition. The ware formed from such formulations were then fired to form the ceramic bond. At all times, the expansion of the aggregate was a separate process; no further expansion within the ware of any of the previously expanded materials (lightweight aggregate) normally occurred.

In contrast, the process in question achieves simultaneously during firing within a piece of ceramic ware, an appreciable expansion of the unweathered, expansible shale particles, a loss in weight of the ware, a decrease in ware shrinkage, a ceramic bonding of the particles, and a decrease in absorption of the fired product. In no way is the ware disfigured by excessive expansion of the unweathered, expansible shale particles.

Mode of Operation

Mode of Operation. Unweathered, expansible shale as well as all other aggregates are crushed and screened to the typical particle size distribution such as that shown below in Table I.

Table I—Typical Sieve Analysis of Ceramic Block Aggregates

Tyler Standard Mesh	*Percent Retained*
8	2.6
10	11.5
14	26.3
20	15.2
35	17.4
48	4.2
Pan	22.8

The crushed expansible shale is then used as the bonding phase of a ceramic body composition from which ware is formed by employing conventional or slightly modified concrete block forming machinery. The particle size distribution of all aggregates, expansible, expanded or nonexpansible, refractory or bonding phase, are substantially the same. To the dry homogeneously mixed particles of aggregate that comprise the composition being used, not less than 7% or more than 17% by weight of water is added. Along with the water, not less than ¼% of the gross weight of some kind of binder material is added that will impart adequate dry strength to the ware upon drying of the body.

It is usually advantageous to disperse or dissolve, as the case may be, the dry strength binder material in the water. This distributes the binder material uniformly throughout the composition mixture; consequently, this optimum distribution results in a maximum amount of dry strength in a piece of ware from a minimum amount of dry strength binder.

The dry aggregate particles, water, and dry strength binder material are intimately mixed, and this mixture is subsequently formed into the desired ware geometry by employing conventional or slightly modified concrete block machinery. This ware is thereupon dried to 1% moisture content or less and subsequently fired in a kiln on a predetermined schedule

Table III—Ceramic Block Compositions and Physical Properties Using Pyrophyllite as the Refractory Phase Aggregate and Volcanic Breccia as the Bonding Phase Aggregate

Aggregate	*P.C.E.*	*Parts by Volume**
Pyrophyllite	29-31	5
Volcania Breccia	8	3
Water	—	1.2

Fired to Cone 8

Liquid lignin sulfonic organic binder—¾" by weight of gross components.
*See Table I for typical sieve analysis

Physical Properties of Table III Ceramic Block

Compressive Strength	*Weight*	*Dimensions*	*Shrinkage*	*Absorption*
1476. psi	25.3 lbs.	3-Core (5.3" x 8" x 16")	0%	6.6%

Table IV—Ceramic Block Composition and Physical Properties Using Pyrophyllite as the Refractory Phase Aggregate and Brick Grog as the Bonding Phase Aggregate

Aggregate	*P.C.E.*	*Parts by Volume**
Pyrophyllite	29-31	5
Brick Grog	15	3
Water	—	1.2

Fired to Cone 15

Liquid lignin sulfonic organic binder—¼% by weight of gross components.
*See Table I for typical sieve analysis

Physical Properties of Table IV Ceramic Blocks

Compressive Strength	*Weight*	*Dimensions*	*Shrinkage*	*Absorption*
1500.0 psi	25.4 lbs	3-Core (5.3" x 8" x 16")	0%	6.8%

of which the time segment is no less than seven hours.

The firing schedule is so controlled so that the Orton Standard Pyrometric Cone achieved by this schedule, is substantially the P. C. E. (Pyrometric Cone Equivalent) of the particular unweathered, expansible shale that is used as the bonding phase. A.S.T.M. (American Society of Testing Materials) Designation C 24-56 procedure is used to determine the particular P.C.E. of the unweathered, expansible shale.

Typical Body Composition

A typical body composition using unweathered, expansible shale particles as a part of the composition is shown in Table II (p. 60). Materials listed in Table II were intimately mixed and subsequently formed into 5.3" x 8" x 16" 3-core ceramic blocks by the use of conventional or slightly modified concrete block machinery. These blocks were thereupon dried to 1% moisture content or less and fired to Orton Standard Pyrometric Cone 5. The resulting fired ceramic blocks had the following nominal physical properties:

Weight, lbs.: 20; Shrinkage, %: 0.8; 24-Hour Cold Water Absorption Percent: 9.5; Compressive Strength, psi: 1700.

The absorption and compressive strength were determined by the procedure outlined in the A.S.T.M. Designation C 140-39 for concrete block.

If in the typical body composition described above the binder phase aggregate (the unweathered expansible shale) were replaced with lightweight aggregate that was manufactured from material obtained from the same shale deposit from which the unweathered, expansible shale was quarried, different ceramic block physical properties will result from ware formed and fired from such a composition. These properties are tabulated below:

Weight, lbs.: 19.2; Shrinkage, %: 1.2; 24-Hour Cold Water Absorption Percent: 11.1; Compressive Strength, psi: 1480.

Examining Cross-Sections

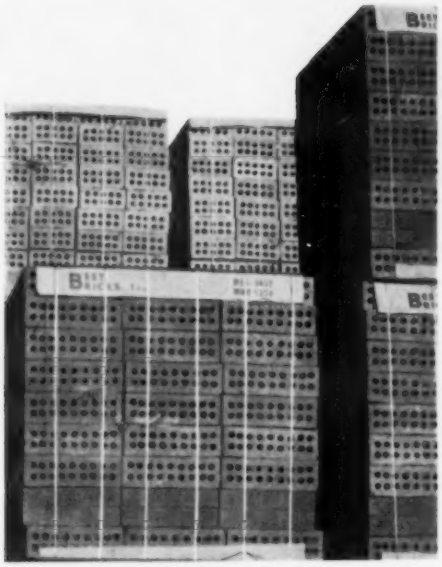
Two ceramic blocks, one in which the bonding phase was comprised of previously expanded shale (commercial lightweight aggregate), and one in which the bonding phase was comprised of unweathered, expansible shale (quarry screenings), were cut with a masonary saw. This was done in order to get a visual relationship of the degree of partical expansion obtained by expanding within the ware the expansible shale in comparison to the degree of expansion obtained when commercial lightweight expanded shale aggregate was used as the bonding phase. Figures 1 and 2 are photographs (10x) of just such intragranular cross-sections. Can you tell which is which? At the close of this article, the figure that contains the $1.50/ton expansible shale as the bonding phase will be revealed; however, do not be surprised if you are wrong.

Refractory Phase Expansion

Expansion of the Refractory Phase Aggregate. If the same expansion mechanism, previously discussed, simultaneous glass formation and gas evolution, were to be used to achieve bloating in the refractory aggregate phase of a ceramic block composition, the basic rule of ceramic block formulation would be violated. It is the refractory phase that surpresses the majority of the firing shrinkage and deformation as result of load during firing. Also, the firing schedule is predetermined by the P.C.E. of the bonding phase aggregate. Hence, the achieving of a glassy state in the refractory phase aggregate, would destroy its function; therefore, an aggregate material that may expand by a mechanism that does not involve the formation of a glass is essential if the refractory phase is to expand during firing and still perform its pyrochemical functions.

The refractory mineral pyrophyllite is an excellent example of a material that is relatively refractory and will expand in the solid state. Also, the use of pyrophyllite (P.C.E. 29-31) as the refractory phase aggregate suggests that by employing this expansible mineral in a ceramic block composition, a concrete block size refractory shape can be manufactured for refractory service. The compositions and physical properties of ware formed and fired from such formulations are listed above in Table III and Table IV as an example

(*Continued on page* 83)



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General view of Glen-Gery's rebuilt shale plant at Reading, Pa.

Glen-Gery Modernizes with

Rebuilt Shale Plant

The Reading (Pa.) shale plant of the Glen-Gery Shale Brick Corp. has taken on a new look. Last year at this time 20 periodic round downdraft kilns stood where today is a modern and efficient 372-ft. long tunnel kiln housed in an all-steel building, along with dryers and new brick forming equipment. Demolition of the old kilns started in October of 1960, with construction of the new tunnel kiln starting in January, 1961. The kiln was lit and the drying out process started on June 16 and by the first week in July, the first car of brick was out of the kiln, and on its way to the customer.

Continuing its present modernization and improvement program, the Glen-Gery Shale Brick Corp., Reading, Pa. has just completed the complete rebuilding of the Reading shale plant, one of the oldest in the organization. Replacing 20 periodic beehive kilns with a modern tunnel kiln was just one of the phases of improvement in the Reading plant. In addition to the new tunnel kiln, the entire grinding system was revamped and two new brick machines were installed in the forming room of the plant.

Demolition of the old periodic kilns began in October of 1960 and was complete by December of that year. While the demolition was going on work on the grinding room was being performed so that it could keep up with the new facilities which were being planned for the Reading plant. Two American 384 dry pans which were operating for many years were completely rebuilt and two sets of four screens by Star Foundry on existing framework were added.

Construction Processes

In January 1961, actual construction of the new facilities was started. A modern all-steel building was erected and the foundation poured for the new tunnel kiln. While the Harrop Ceramic Service engineers were busy erecting the kiln, Glen-Gery's own engineers were busy erecting the new machine room and green storage area for the new plant. Two new Chambers brick machines with pug mills were installed, along with two Chambers #32 cutters. And then something new was added. Two Schweitzer Equipment Co. spray booths were also installed in the production line immediately after the cutter for possible future use in the manufacture of glazed ware and colored engobe coatings.

Three hacking tracks were installed in the setting area of the plant.

The three tracks are common to both machines, so if necessary it is possible to run both machines at the same time, setting half a car height from the first machine and completing the setting on the kiln car from the second machine line. This will probably be the case when requirements call for both machines to be making the same type of brick simultaneously. However, the original design of the machine room was intended so that the hacking crew of six men could transfer from one machine line to another immediately when the production department was required to make two different types of brick the same day. The down time of the hackers is then eliminated while die changes are being made on one or the other machine.

Green storage was provided for the weekend necessities of the tunnel kiln by a 3-track storage area capable of holding 60 cars. In addition to the 60-car green storage area, an additional 15-car storage area had been added between the kiln and the dryer for dry brick.

Hydraulic Pushers

Movement of the kiln cars through the setting area is accomplished by hydraulic setting track pushers furnished by Engineering Associates, Inc. A total of six of these pushers have been installed, one on each track in front of each machine. The kiln cars themselves are 9-ft. 2-in. long, but built considerably wider than a standard 8-brick wide kiln car. The cars were especially designed for the manufacture of 12-inch brick along with standard brick, which means that when standard brick are hacked, an extra wide flue of 16-in. is maintained down the center of the 3500-brick set.

From the green storage area, the cars are transferred by Engineering Associates hydraulic transfer car to one of two single track dryers running parallel to each other and located along side of and parallel to the kiln. Each of the dryers is 130 ft. long and hold 14 (active) kiln cars.

One waste heat duct running from the cooling zone of the kiln down the space between the dryers feeds waste heat from the kiln to both dryers. The temperature and recirculation in the dryers are both individually controlled with one dryer independent of the other. Six fans on each dryer provide absolute control of internal conditions at all times. In addition to the waste heat supply fan there are three recirculating fans, an exhaust fan and an additional waste heat fan at the charging end of the dryer which is used to keep the charging end warm and also used to control humidity by additions of either waste heat or external cold air. Temperatures of the dryer range from 120° at the charging end to 325° at the discharge end of the dryer.

Each dryer is divided into four separate controlled zones. Starting at the cold end of the dryer, the movement of the air through the dryer and the setting of the cars is down from the top of the dryer and out both sides. At the No. 2 zone, the movement of air is in one side of the setting and exhausted out the other. This condition is reversed in the No. 3 zone, while in the fourth zone, the movement of the air is down from the top only. Each of these zones is equipped with inspection doors so the progressive drying of the brick can be checked periodically.

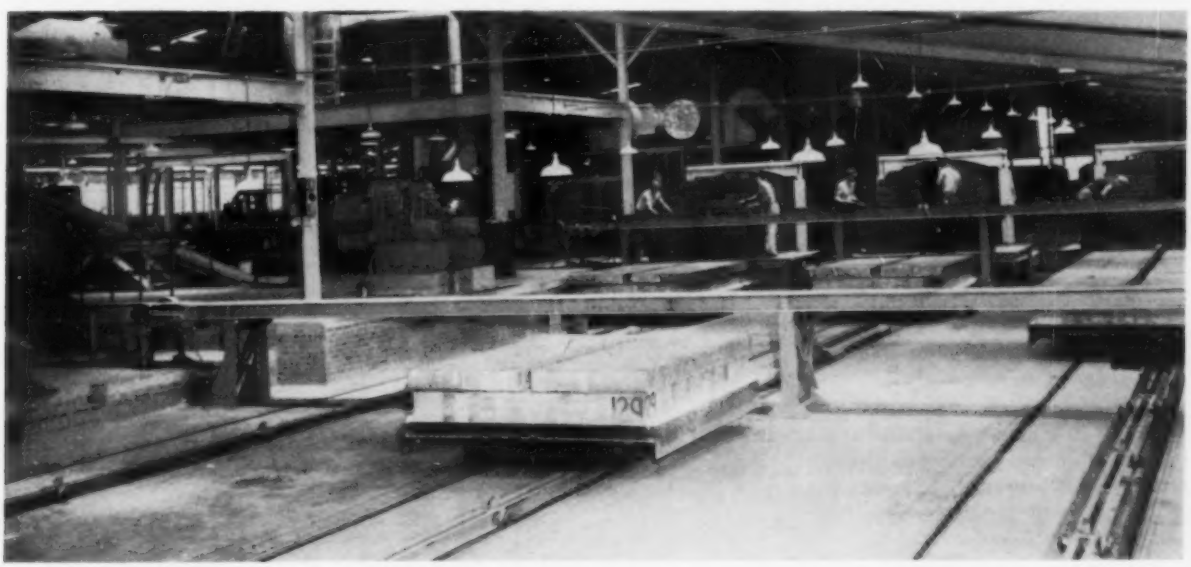
Cars of dry brick are pulled from each dryer alternately and transferred by another hydraulic transfer car to the 372-ft. Harrop kiln. The kiln itself has a tunnel width of 7-ft. 4-in. and was designed to produce a minimum of 80,000 brick equivalents every 24-hours.

Two Sets of Doors

The 11-ft. vestibule on the kiln is equipped with two sets of guillotine doors which are operated automatically so the drafts inside the kiln are not disturbed whenever a car is charged into the kiln. As the outer doors are opened to charge a car, the inner doors close, and when the car has been charged, the outer doors close, the inner doors open and the scheduled push begins.

The auxiliary recirculation and preheat zone of the kiln is 134-ft. 10-in. long. There are three recirculation zones, each 18 ft. long, in this section. Recirculation is through the

General view of machine room showing the two hacking belts over the three setting tracks. Six hackers will be used to set the entire production of the plant.



The new gas producer produces sufficient amount of 150 BTU gas for the new tunnel kiln. Anthracite coal is the primary fuel used for this operation.

sidewalls of the kiln into the setting plus three blast heads in each section and in the crown of the kiln blowing counter to the normal draft and towards the furnace section of the kiln. This recirculation is provided by three high-temperature Garden City fans with booster heat provided by an auxiliary burner in each section and on each side of the kiln.

Automatic System

Automatic draft control is provided internally by dampering the exhaust fan with an automatic system developed by North American Mfg. Co. The control point is located approximately 15 feet inside the hot end of the charging section of the preheat section and is a measurement of the crown draft of the combustion gases. The kiln exhaust gases themselves are diverted by an underground flue to a sand dryer which will be used to dry the sand used in the manufacturing process to coat the brick.

A series of thermocouples located at the bottom of the kiln at strategic locations indicates the temperatures on the car top. The temperatures can be controlled by dampers located in the side of the kiln and are adjusted so the temperature always shows a gradual progressive rise. Fifteen of these thermocouples on each side of the kiln are connected to indicators supplied by Pyrometer Instrument Co. (Thermocouples by Minneapolis-Honeywell; indicators by Pyrometer Instrument Co.)

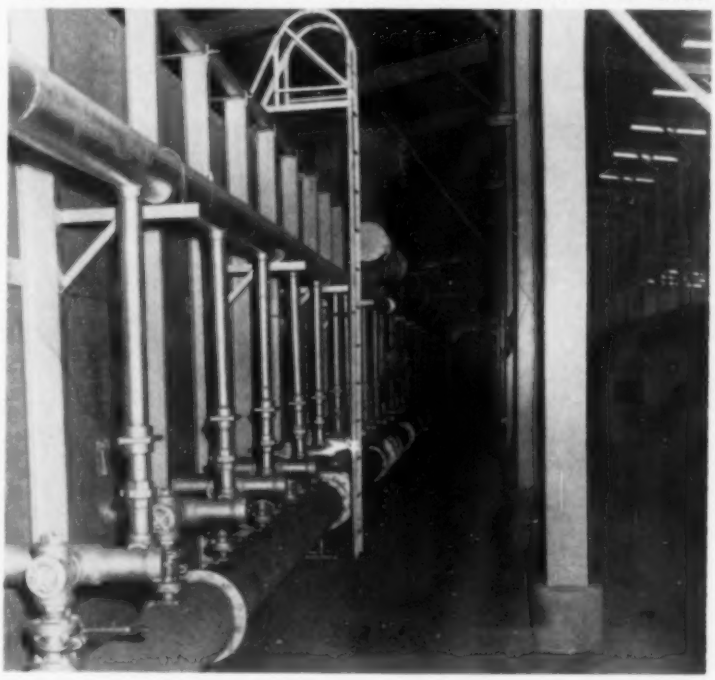
All the burners on both the preheat and the furnace zone of the kiln were especially designed by Harrop and Glen-Gery engineers for burning producer gas, which all Glen-Gery plants use. A gas-producer located adjacent to the main kiln building provides sufficient 150-BTU/cu. ft. gas for the operation. Nine of these especially designed burners are located on each side of the preheat zone, along with one additional burner in the crown at this point. A 5-hp North American blower provides the primary combustion air for both the auxiliary burners and the preheat burners.

The 125-foot long furnace zone, holding 13 cars, is divided into two control zones. Temperatures inside the furnace zone are controlled automatically in these two control zones by controlling the gas supply with a Minneapolis-Honeywell pneumatic controller. In burning producer gas, a theoretical fuel to air ratio is 1 to 1.1 and in practice a ratio of 1 to 1 is maintained. As the gas supply changes, the amount of air is also automatically changed by automatic controls, keeping the gas to air ratio constant. There are 26 side burners on each side of the fire zone plus five additional crown burners in this zone. A 5-hp blower for each controlled zone provides combustion air for these burners.

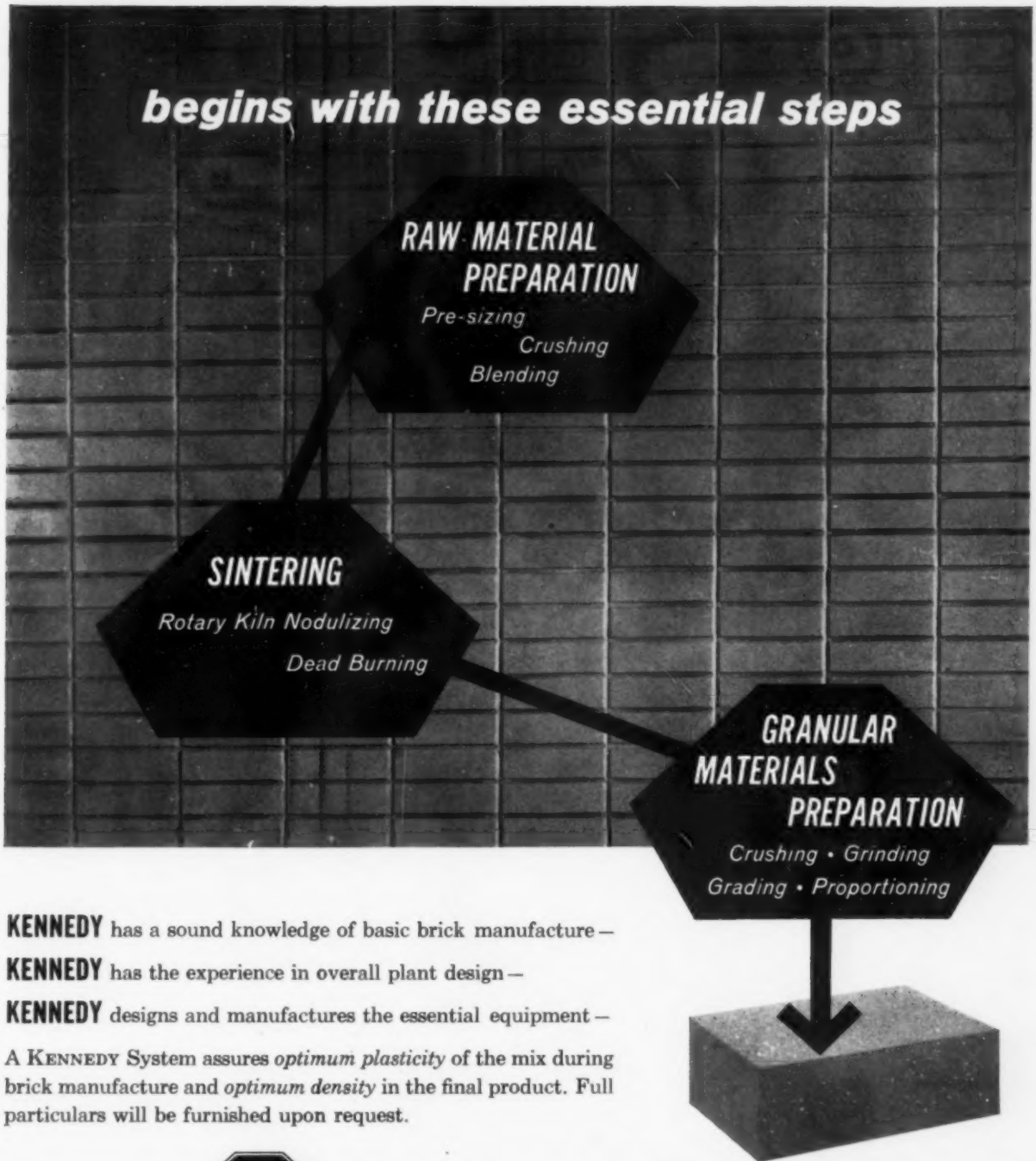
Instrumentation of the kiln is thorough, with 39 thermocouples located throughout the crown of the kiln connected to a 48-point precision indicator. In addition to these thermocouples are the two control thermocouples connected to two circular chart controller-recorders. All instruments were provided by Minneapolis-Honeywell.

Continued on page 80

Specially designed burners had to be fabricated for burning the producer gas. Shown here is the furnace zone of the new tunnel kiln and the line of burners.



QUALITY BASIC BRICK



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Trucks Favored, Survey Shows

How Does Clay Industry Ship?

Detailed studies of specific subjects are made by the editors when such information is requested by a number of readers. This study analyzes the shipping problem, discussing rails, trucks, contract haulers and company owned fleets. Reasons for choices are given.

Coupled with proper packaging of clay products is the means by which the package of brick, tile, pipe and refractories is shipped. To fully understand shipping methods in the heavy clay products industry, editors of BRICK & CLAY RECORD questioned the industry.

Shipping by rail or truck, in many cases, influences breakage, service and cost. Since practices varied in different parts of the U. S. because of road availability, rate differentials and distances covered, the U. S. was studied by regions established by the Census Bureau.

Six questions were asked. Answers are tabulated in the text set on wide measure.

In summarizing the study, it indicates that clay product plants are getting away from rail shipments and tending toward truck shipments. Many of the replies indicated that losses were lower via truck than via rail. Some also said that because of handling packaged units, it was easier to handle them by truck, especially since special trucks are made for the purpose. Door-to-door shipment meant a great deal. Truckers can deliver directly on the job, whereas rail shipments must be rehandled.

There is, however, one great discrepancy in truck shipping. Whether owning your own fleet or using a contract hauler is better has not been determined. Some of the shippers would rather use contract haulers because of the reduced responsibility of maintenance, capital investment, etc. Others would rather have their own fleets because they can maintain a better control of shipments and deliveries.

1. *What percentage of your shipments are made by rail?*

In the northern half of the country it seems that railroad shipping facilities are used more as the location proceeds eastward. In the south it is just the reverse, with more rail shipments being made in the western part of the south than in the eastern part of the south. Canada straddles the middle.

The number of plants not using rails at all, of course, is in proportion to the amount shipped by rail. Where the amounts shipped are low, it is obvious that more brick plants stay away from rail shipments.

Here is an indication that more plants could utilize railroad facilities for transporting their products. It indicates that fewer than a quarter of all clay products made are shipped by rail.

	% of Brick Shipped by Rail —Range	*Average of All Plants*	*% Who Do Not Ship by Rail*	*Replies*
PACIFIC				
Wash., Ore., Calif.	0-70%	5.70	73.0	22
MOUNTAIN				
Mont., Ida., Wyo., Nev., Utah, Colo., Ariz., N. M.	0-25%	2.30	69.2	13
WEST NORTH CENTRAL				
N. D., S. D., Minn., Neb., Iowa, Kas., Mo.	0-50%	8.23	14.3	21
EAST NORTH CENTRAL				
Wis., Mich., Ill., Ind., Ohio	0-90%	17.10	19.0	63
MIDDLE ATLANTIC				
N.Y., Penna., N. J.	0-90%	17.20	11.0	23
NEW ENGLAND				
Vt., N.H., Me., Mass., Conn., R. I.	0-10%	25.00	50.0	4
SOUTH ATLANTIC				
Del., Md., W.Va., Va., N. C., S. C., Ga., Fla.	0-100%	15.20	47.3	36
EAST CENTRAL				
Ky., Tenn., Miss., Ala.	0-85%	30.30	15.8	19
WEST SOUTH CENTRAL				
Okla., Ark., Tex., La.	0-100%	30.00	18.20	22
CANADA	5-80%	22.70	0	6

2. *What percentage of your shipments are sent by truck?*

The clay products industry has moved toward truck shipments considerably in the past 20 years. The reason for this evidently is the better service that the industry is able to get by truck, also the fact that they can own their own truck fleets, or control a truck fleet which does the shipping for individual plants. It indicates that over ¾ of all the clay products made are shipped by truck. There are very few plants that do not use trucks to some extent.

	Range	*Ave.*	*No. Truck*
PACIFIC	30-100%	79.5	0
MOUNTAIN	75-100%	95.	0
WEST NORTH CENTRAL	10-100%	75.0	0
EAST NORTH CENTRAL	0-100%	74.0	1.5
MIDDLE ATLANTIC	10-100%	77.0	0
NEW ENGLAND	30-90%	72.5	0
SOUTH ATLANTIC	2-100%	78.7	0
EAST CENTRAL	10-100%	67.0	0
WEST SOUTH CENTRAL	14-100%	70.5	0
CANADA	20-95%	73.5	0

3. *What percentage of your shipments are picked up by the user?*

This question was a very interesting one and one which seemed greatly to depend on the distances covered in serving the market area of each plant. Where the distances were very short, it seemed that the contractor was willing to pick up his own clay product. Where the distances were long, of course, rails or trucks were used. Only a very few plants had their entire output picked up by either a dealer or a contractor.

	Range	*Ave.*	*Plants Which Have 100% Pickup*
PACIFIC	0-100%	28.4	9.0
MOUNTAIN	0-25%	9.0	0
WEST NORTH CENTRAL	0-90%	14.8	0
EAST NORTH CENTRAL	0-100%	17.7	4.8
MIDDLE ATLANTIC	0-60%	19.5	0
NEW ENGLAND	10-70%	25.0	0
SOUTH ATLANTIC	0-15%	6.3	0
EAST CENTRAL	5-30%	2.8	0
WEST SOUTH CENTRAL	0-25%	4.7	0
CANADA	0-25%	13.0	0

4. *If you would divide your trucking shipments several ways, how much of your truck shipments are sent by contract hauler?*

The general trend in this category seemed to be the concentration of plants. Where there was a great concentration of plants there were contract truckers available to do the hauling. Also where there were large plants, contract truckers were available and used exclusively in many cases. Distances do not seem to matter too much in this case. Probably some brick plants would avail themselves of contract haulers if they were available in their territory. Also where contract haulers have special trucks for hauling clay products, they are able to do a bigger business.

	Range	*Ave.*	*100% Contract Haul*
PACIFIC	0-100%	28.4	9.0
MOUNTAIN	0-100%	4.6	7.8
WEST NORTH CENTRAL	0-100%	49.0	14.2
EAST NORTH CENTRAL	0-100%	31.3	17.7
MIDDLE ATLANTIC	0-100%	46.5	8.7
NEW ENGLAND	0-60%	15.8	0
SOUTH ATLANTIC	0-100%	29.3	15.4
EAST CENTRAL	0-100%	21.6	10.5
WEST SOUTH CENTRAL	0-100%	14.5	13.6
CANADA	0-65%	29.0	0

5. *What percentage is shipped by your own trucks?*

This category seemed to work in reverse of the category in Question 4; where contract haulers were not used, the manufacturers owned their own trucks. Here again it was noted that large shippers had their own fleets and used contractors as well. Where distances were great and fewer plants were located more emphasis was placed on ownership of trucks by the plant. About 30% of the clay products are shipped by company-owned trucks and a little over that amount shipped by contract haulers. The remainder goes by rail.

	Range	*Percent*	*100% Own Trucks*
PACIFIC	0-100%	53.1	27.3
MOUNTAIN	0-100%	69.8	8.5
WEST NORTH CENTRAL	0-100%	24.5	9.5
EAST NORTH CENTRAL	0-100%	20.4	6.7
MIDDLE ATLANTIC	0-100%	22.0	8.7
NEW ENGLAND	0-90%	52.5	0
SOUTH ATLANTIC	0-100%	62.0	16.6
EAST CENTRAL	0-95%	39.3	5.3
WEST SOUTH CENTRAL	0-100%	62.2	27.3
CANADA	0-90%	40.0	0

6. *If you use contract hauler, does he work exclusively for you?*

Only about ⅓ of the brick shipped by truck is hauled by exclusive or captive haulers. The remainder of brick is shipped by trucking companies which ship other products and for other clay products plants as well. Many of the replies indicated that the respondents did not know if these truck haulers were exclusive for them or not. As to whether the contract hauler works exclusively for one manufacturer, the replies were as follows:

	Yes	*No*	*No Reply*
PACIFIC	67.0	6.0	27.0
MOUNTAIN	15.4	38.6	46.0
WEST NORTH CENTRAL	33.3	38.2	28.5
EAST NORTH CENTRAL	11.1	58.8	30.1
MIDDLE ATLANTIC	21.8	52.0	26.2
NEW ENGLAND	25.	25.	50.
SOUTH ATLANTIC	39.	33.3	27.7
EAST CENTRAL	31.6	37.	31.4
WEST SOUTH CENTRAL	13.3	50.2	36.5
CANADA	0	66.6	33.4

Ken Brinsmean, Shaw Process Development Corp., listens as G. Robert Gast, Cedar Heights Clay Co. discusses the potential of the refractories industry.

How 40-45 Pound Foam ZrO2 and Al2O3 Are Made

A record 385 persons, members of the American Ceramic Society, attended the fall meeting of the Refractories Division held at Bedford Springs Hotel, Bedford, Pa., Oct. 5 to 7.

Two symposiums, "High Temperature Specialties" and "Pouring Pit Refractories," were featured on the program. Members were treated to an "early-bird" cocktail party which was held in the hotel for those arriving on Thursday. John S. Nordyke, ACS president, was the main speaker for the banquet which was held on Friday night. Nordyke discussed the affairs and growth of the society, recalling his experiences in his many years of membership and the numerous offices he has held.

Vapor Deposited Refractories

After the keynote paper of E. S. Bettis, Oak Ridge National Laboratory, Oak Ridge, Tenn., concerning nuclear reactors and their relation to the well-being of our country, L. R. McCreight, General Electric Co., Philadelphia, opened the "High Temperature Specialties" symposium by discussing "Vapor Deposited Refractory Materials." While some vapor deposited coatings have been utilized for many years, the technique is now being rapidly developed to provide free standing, dense, anisotropic materials. Perhaps the best known of these is pyrolytic graphite. However, many other substances can also be prepared by vapor deposition, including ceramic whiskers which have a very high strength and a great potential for reinforcing composite materials.

W. R. Jacoby, Minnesota Mining & Mfg. Co., St. Paul, Minn., then spoke on "Coated Graphite." Coatings for graphite have been developed which serve a twofold purpose—oxidation resistance and, on graphite base fuel elements, a fission product retention barrier. Properties and microstructures of the coatings were discussed together with results of physical and irradiation testing of the coated products.

In his paper, "High Emittance Zirconia and Alumina Foam Materials," Edwin C. Childs, Jr., Melpar, Inc., Falls Church, Va., explained how refractory zirconia and alumina base foam materials were prepared with resultant densities of 45 and 40 pounds per cubic foot, respectively. To improve the surface emittance of these foams a number of oxide additions were tried. The effect of various percentages of nickel, chromium, cobelt and other oxides and combinations of oxides on the surface emittance was measured. The effect of surface roughness of emittance was also determined over a wide range of surface finishes for one alumina composition.

Discusses Microstructures

Lawrence H. Van Vlack, University of Michigan, Ann Arbor, discussed "Microstructures in Refractories." Microstructures of refractories like those of metals involve the geometry of (1) amount, (2) shape, (3) size and (4) distribution of the various grains or phases which are present. With chemical equilibrium the

(*Continued on page* 89)

Left to right, George Seanor, Frank Lamonica, both of Bonnot Co.; Joe Kruson, Kaiser Refractories; Mrs. John Ives; Mrs. Kruson; John Ives, Kaiser Refractories, and Roy Ehman, Pennsylvania State University.

George Easter, Electro Refractories, weighs in at 198 on the Howe Scale Co. display being attended by Theodore Ketterer.

Bill Gritton, A. P. Green Firebrick Co. watches one of the active demonstrations put on by Larry Rank and Sam Fittes, Clipper Mfg. Co.

Among the diners at the annual banquet were Mr. & Mrs. Z. A. Pest, Melpar, Inc.

Caught by the Brick & Clay Record camera were: Mrs. Clark Holbrook, Mr. & Mrs. R. H. Hughes, R. H. Hughes Co., and Clark Holbrook, Barber-Colman Co.

Below, refractories were certainly being discussed as L. J. Trostel, Sr., General Refractories Co.; Julius Kayser, Gladding, McBean & Co.; H. A. Heiligman, E. J. Lavino Co., and C. L. Norton, Babcock & Wilcox, get together.

21 Feeders Provide

Uniform Blending Of Ten Raw Materials

Installation of weighing type feeders minimizes shading and grading operations at kiln discharge. More uniformity achieved in finished product allowing reproducibility as a result of better raw materials control.

The uniform feeding of 10 different basic raw materials can bring on quite a problem when making many types of colored brick. However, Henderson Clay Products, Inc., Henderson, Texas, has successfully solved this problem in its latest expansion program, which consisted of blending, grinding, manufacturing and burning of equipment for boosting production from 4½ to 6 million brick per month.

The raw materials used at the Henderson plant consist of nine different types of clay, all of which are mined within an 11-mile radius of the plant, and 3 grogs, which are calcined from 3 different types of clay. The grog is calcined through a rotary kiln at 2100°F. This calcining process burns the impurities out of the clay and also takes out some of the burning shrinkage, but the calcining temperature is such that some of the burning shrinkage is left in the grog.

Run Through Shredder

All the clays are run through a Gleason shredder as they are received from the various clay deposits which the company operates. This Gleason shredder takes the run-of-the mine clay and breaks it down to 2-inch sizes and smaller, which is ideal size for a good feeding process, and stacks material onto appropriate stockpiles in a 275-foot by 280-foot covered clay storage building.

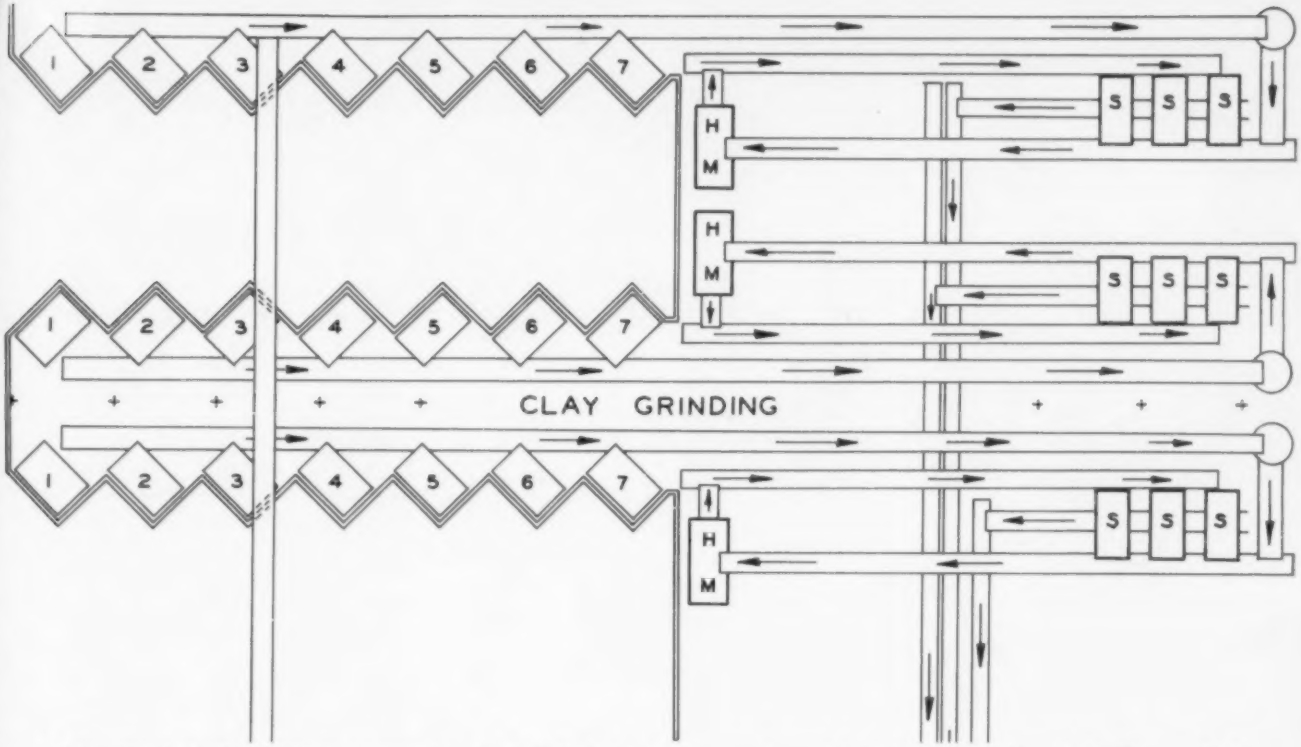
Two Michigan front-end loaders are used to take the material from one of the 9 separate storage areas in the clay storage building to one of the three blending and feeding lines in the raw materials grinding and screening circuit. A third front-end loader is kept in reserve for supplementary work and for odd jobs around the plant.

Three Identical Circuits

Each of the three blending and grinding lines feeds a brick machine in the forming room of the plant, and each of these lines is operated independently from one another. All three lines are also identical. The front-end loader deposits the appropriate material into one of seven raw material hoppers in each of the circuits. These hoppers are located at 45° angles to the common collector belt, for easy access by the front-end loaders.

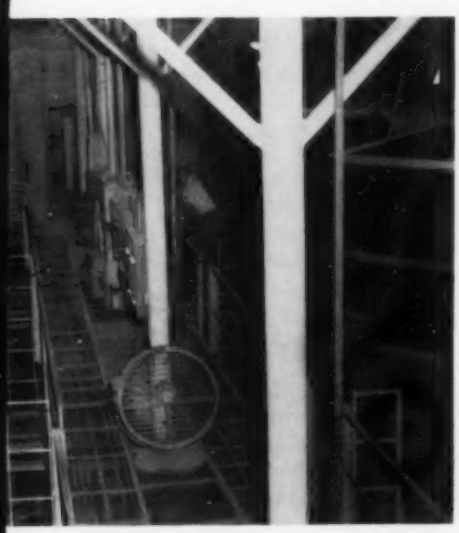
Under each of the hoppers is located the key to the entire successful

All the clays are run through a Gleason shredder and stockpiled for future use.



Schematic of blending, grinding and screening circuit at Henderson Clay Products, Inc. The feeders are located under each of the seven hoppers in each circuit. (H-M refers to Hammermill, S refers to Screens)

blending process; the Waytrol feeders. They are the weighing type feeder which actually weigh the amount of material being deposited onto the common belt leading to the grinding and screening operations. Operating in batteries of seven on each of the three blending lines, these Jeffrey Waytrol feeders each have two main components; a variable rate vibrating feeder, and a weighing section controlling the variable rate feeder.



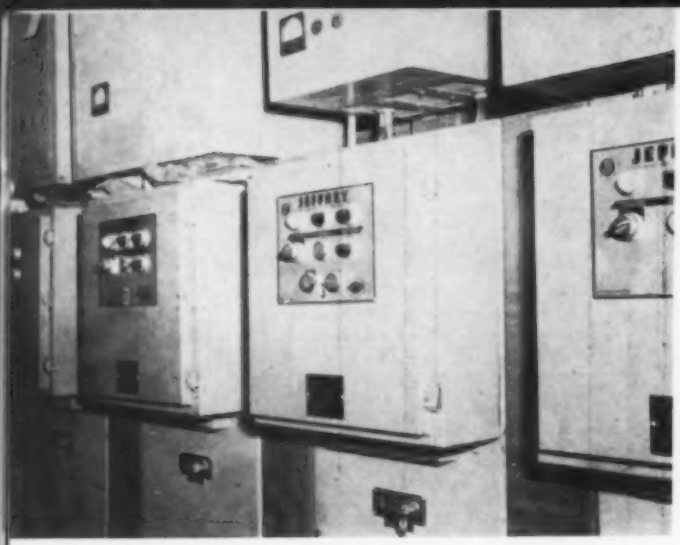
The raw material hoppers in each circuit are filled with various types of material. Under each of these hoppers is located a gravimetric type vibrating feeder.

The weighing section is essentially a set of scales. A very short endless belt mounted similar to a platform scale and having a load length predetermined by the manufacturer, and with the necessary control circuit, is the weighing portion of the feeder. The scale beam is calibrated to give a direct reading in pounds of material per lineal foot of belt. The belt speed in feet per minute, which is fixed, multiplied by the scale setting in pounds of material per foot gives the pounds of material per minute being added to the blend.

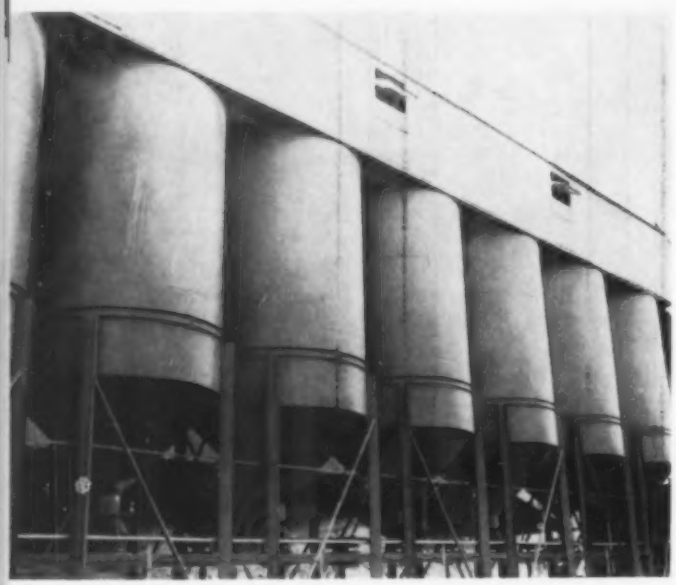
The Waytrol does the actual measuring of material and when underfeeding or overfeeding, senses this, and transmits the error to the control circuit, which in turn controls the variable rate feeder placing the material on the weighing portion of the belt.

To prevent a continuous error of over or under rate of scheduled feed, the control circuit has a built in warning and control systems. Should any one of the weighing feeders in a line weigh continuously in error for more than fifteen seconds, a warning signal sounds and a red light shows the unit or units in error. If the error continues for another fifteen seconds, the control circuit stops all weighing feeders and the collector belt in that line leaves a red light showing which of the feeders was not functioning properly. It is then necessary to manually start the system after the cause of error has been determined. The system, as Henderson employs it, permits erroneous weighing for a maximum of only thirty seconds.

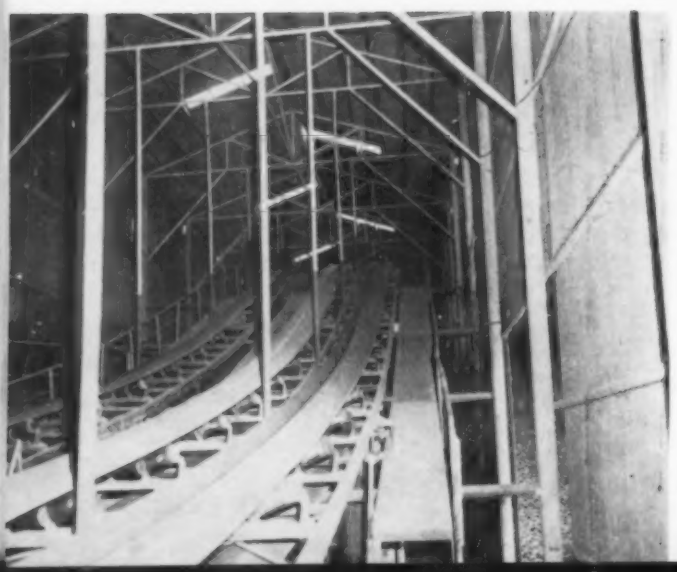
A vibrating feeder is the feed mechanism for the Jeffrey Waytrol system in this installation, although other types of feeders are adaptable to this system. With the Henderson system, an accuracy of plus or minus ½ or 1 percent of the desired weight of each of the materials is possible; much more accuracy than is possible with a volumetric type of feeders. The proportions of desired material are set individually at each feeder at the scale beam and with the right composition for a particular brick being known, it is now possible for



Heart of the entire blending process is this control station. Should any one of the feeders in the line weigh in error continuously for more than 15 seconds an alarm is sounded. Should the error continue another 15 seconds the control system stops all weighing feeders.



Seven grog storage tanks located outside the main grinding plant are used to maintain a supply of grog for the operation.



After the material has been blended, these three conveyors deliver the raw material to one of three brick machines.

Henderson Clay Products to reproduce this brick at any time, be it a week or six months from the last time it was in production.

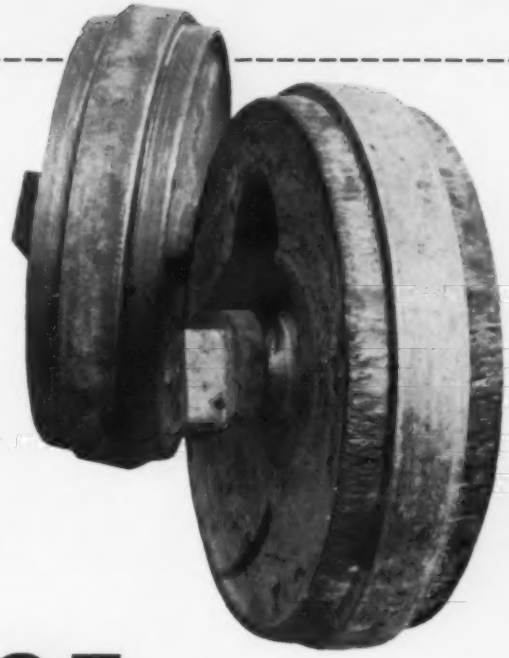
From Jeffrey Waytrol Blending system the blended material is fed to Miller Hammermill, then to battery of 3 Overstrom 4' x 10 heated screens. Oversize material from the screens is returned to a Miller Hammermill for further reduction before being returned to the screens for further classifying. The Miller double-rotor hammermills are the only piece of equipment in the circuit for grinding the material. The minus 10-mesh material is then conveyed to one of two surge hoppers located near each of the brick machines. When these hoppers are filled, the entire grinding operation in that particular circuit is stopped until there is further storage space for more blended and ground material. Thereafter the flow from the hopper is in the hands of the pug mill operator.

Similar Handling for Grog

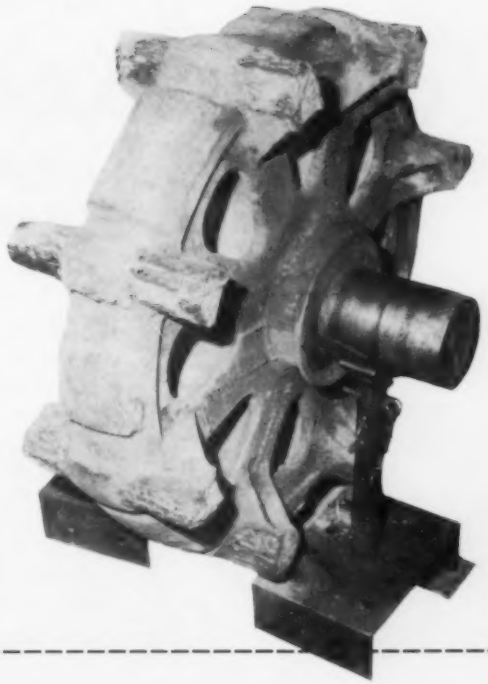
Grog is handled and proportioned the same way as the clays, with a slight variation in the preliminary grinding process. A Jeffrey 36-in. by 60-in. pulverizer with a Jeffrey vibrating feeder is used for crushing of the calcined grog after it leaves the rotary kiln. The vibrating feeders rate of feed is continuously controlled by amperage demand of Hammermill motor, eliminating over-or underfeed of Hammermill. The material is then screened to 14 mesh size, and conveyed to one of seven grog storage tanks located outside the grinding areas and then conveyed from these tanks to the appropriate Waytrol hopper in each of the three blending lines. It is then blended with the clays as described earlier.

The advantage of the new blending system have been obvious to the plant management. In addition to the fact that a brick can now be reproduced time after time, the shading and grading difficulties caused by improper feeding and blending of the many raw materials has been eliminated. Combine with this the impractical situation of keeping a sufficient amount of more than the hundred colors, blends and textures of colors in inventory, and one can see the necessity for close raw material control at the beginning of the manufacturing process.

popular Stoody 105 available as Manual Electrode...



STOODY 1105



For the company maintenance shop desiring to rebuild its own heavy machinery undercarriage parts, but not having sufficient rolling stock to warrant the installation of automatic welding equipment... *here is the ideal electrode.* Providing the same deposit properties as the widely used Stoody 105 automatic hard surfacing wire, Stoody 1105 may be used for hard-facing tractor rollers and idlers, arch wheels, shovel rollers and idlers, charging car wheels and sprockets, as well as churn drills and other equipment subject to severe impact and abrasion and metal-to-metal wear.

Literature describing STOODY 1105 is available. See your nearest STOODY DISTRIBUTOR (check the "Yellow Pages" in your phone book) or write direct.

STOODY COMPANY

11950 E. Slauson Avenue • Whittier, California

Circle Service No. 31

SLATTED TO SUIT YOUR SITUATION

There's a Chase Dryer Car style suitable for handling every type of ware from heavy clay to porcelain.

Standard Chase Dryer Cars can be adapted to suit your special requirements. Variations in length, width and deck style are available at little or no additional cost, depending upon how extensive the changes are.

Cars are fabricated of mild steel plate with high-carbon channel slats to give extra life to decks. Welding is done in jigs to assure perfect alignment and interchangeability of parts. Castings are high-grade gray iron. Dependable Chase Flexible Bearings keep cars rolling smoothly for years.

Don't settle for cars that give less service. Next time, order durable Chase Dryer Cars — used in over 80% of U. S. brick plants.

WRITE FOR CATALOG OR SEND SPECIFICATIONS FOR A PROMPT QUOTATION

Chase FOUNDRY & MANUFACTURING CO.

2350 Parsons Avenue • Columbus 7, Ohio

Circle Service No. 33

Parmanco

SPECIALISTS IN AUGER TYPE DRILLS

NOW . . . GREATER DRILLING POWER

MODEL F-86B
Mounts on any ½ ton or larger truck

A DRILL THAT DOES THE JOB FASTER AT LESS EXPENSE TO YOU!

- Full 6′ twin hydraulic cylinder feed for faster drilling and more pulling power.
- Simplified control. All controls are centralized at rear of drill.
- Time saving clutch. Three speed independent transmission and 10″ spring loaded truck clutch.
- Auger drills to 100 feet.

Complete information on request.

MODEL F-86
Jeep mounted

PARIS MANUFACTURING COMPANY
PARIS, ILLINOIS

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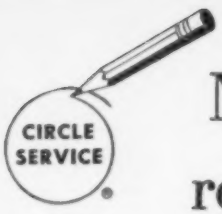

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Simply circle the number corresponding to the advertisement or product number on the card. Mail the card and we will do the rest. You may circle as many numbers on one card as you wish.

Use this valuable service to obtain complete information about the many products available to you. Send us one card now and save the second card for later use.

Brick & Clay Record
P.O. Box 3382
Merchandise Mart Sta.
Chicago 54. Illinois

1	16	31	46	61	76	91	106	121	136	151	166	181	196	211
2	17	32	47	62	77	92	107	122	137	152	167	182	197	212
3	18	33	48	63	78	93	108	123	138	153	168	183	198	213
4	19	34	49	64	79	94	109	124	139	154	169	184	199	214
5	20	35	50	65	80	95	110	125	140	155	170	185	200	215
6	21	36	51	66	81	96	111	126	141	156	171	186	201	216
7	22	37	52	67	82	97	112	127	142	157	172	187	202	217
8	23	38	53	68	83	98	113	128	143	158	173	188	203	218
9	24	39	54	69	84	99	114	129	144	159	174	189	204	219
10	25	40	55	70	85	100	115	130	145	160	175	190	205	220
11	26	41	56	71	86	101	116	131	146	161	176	191	206	221
12	27	42	57	72	87	102	117	132	147	162	177	192	207	222
13	28	43	58	73	88	103	118	133	148	163	178	193	208	223
14	29	44	59	74	89	104	119	134	149	164	179	194	209	224
15	30	45	60	75	90	105	120	135	150	165	180	195	210	225

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COMPANY _____

STREET _____

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2	17	32	47	62	77	92	107	122	137	152	167	182	197	212
3	18	33	48	63	78	93	108	123	138	153	168	183	198	213
4	19	34	49	64	79	94	109	124	139	154	169	184	199	214
5	20	35	50	65	80	95	110	125	140	155	170	185	200	215
6	21	36	51	66	81	96	111	126	141	156	171	186	201	216
7	22	37	52	67	82	97	112	127	142	157	172	187	202	217
8	23	38	53	68	83	98	113	128	143	158	173	188	203	218
9	24	39	54	69	84	99	114	129	144	159	174	189	204	219
10	25	40	55	70	85	100	115	130	145	160	175	190	205	220
11	26	41	56	71	86	101	116	131	146	161	176	191	206	221
12	27	42	57	72	87	102	117	132	147	162	177	192	207	222
13	28	43	58	73	88	103	118	133	148	163	178	193	208	223
14	29	44	59	74	89	104	119	134	149	164	179	194	209	224
15	30	45	60	75	90	105	120	135	150	165	180	195	210	225

NAME _____ TITLE _____

COMPANY _____

STREET _____

CITY _____ ZONE ___ STATE _____

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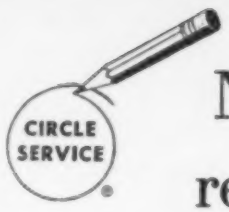

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Brick & Clay Record
P.O. Box 3382
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Chicago 54, Illinois

New Sales Officer

Paul E. Smith, associated with The Chase Foundry & Mfg. Co., Columbus, Ohio since 1945, has been appointed to the new post of vice president, sales. He formerly served as chief engineer and purchasing agent.

Following graduation from Ohio State University in 1939 with a degree in mechanical engineering, Smith worked as an engineer for coal mining and natural gas producing firms.

The Chase Foundry & Mfg. Co. has manufactured dryer cars, kiln cars, transfer cars and other equipment for brick and ceramic plants since 1897.

Norton Official Dead

Howard J. Daly, 64, vice president and director of Norton Co., Worcester, Mass., died recently at Niagara Falls.

He was general manager of Norton's electric furnace plants at Chippewa, Ontario; Cap-de-la-Madeleine, Quebec; and Huntsville, Alabama.

Daly had been with Norton since 1922 when he joined the company as a quality control engineer soon after graduation from Tufts College with a degree in chemical engineering. He successively served as assistant superintendent, superintendent, works manager, manager and general manager of the electric furnace plants.

He leaves a widow, three sons, and five grandchildren.

Clearfield Appointment

The Clearfield Machine Co., Clearfield, Pa., manufacturers of muller-type mixers and grinders for the ceramic foundry and chemical processing industries, announced the appointments of agents in Chicago, Pittsburgh and Ft. Thomas, Ky.

Arthur F. Ries of Chicago was named the Clearfield agent for Illinois, Wisconsin and Iowa, and Ferdinand G. Schultz Co., for western Pennsylvania and West Virginia. Ernest A. Hund with offices in Ft. Thomas, Kentucky will cover Kentucky, Indiana and Southern Ohio including Columbus and Springfield.

New Consulting Engineer

The Kennedy Van Saun Mfg. & Engineering Corp., New York, N.Y. has announced the appointment of Gerhard Niemitz to the position of consulting engineer with primary responsibility for directing the company's expanding development program. Mr. Niemitz has served for 17 years as chief engineer for Kennedy Van Saun.

Civil War Theme

A century of brick making dating from the Civil War days of 1861 down to the modern methods and machinery being used in 1961 by Connecticut brick manufacturers, was the theme of the exhibit of the Brick Service and Development Association, Inc., of Connecticut, at the Eastern States Exposition, West Springfield, Mass., held recently.

The striking contrasts of handmade, sun-dried brick and today's modern plants and products were detailed in pictures.

new markets! new profits!

with "hand dressed"

BRICK

by PITCHMASTER

Here is a machine that incorporates the skills of the craftsman with more production muscle than twenty men.

Reach NEW markets, NEW profits by offering a NEW brick with greater depth of beauty.

- Culled brick can be converted to premium priced material.
- Fifty lineal feet of "Hand-Dressed" brick per minute.
- Instant adjustment to material height and depth of pitch. No limitation on material length.
- All material is conveyed through machine in a continuous flow by belts and rollers. Machine maintenance is reduced to the absolute minimum.

NEW AND REVOLUTIONARY IN DESIGN! TESTED AND PROVEN

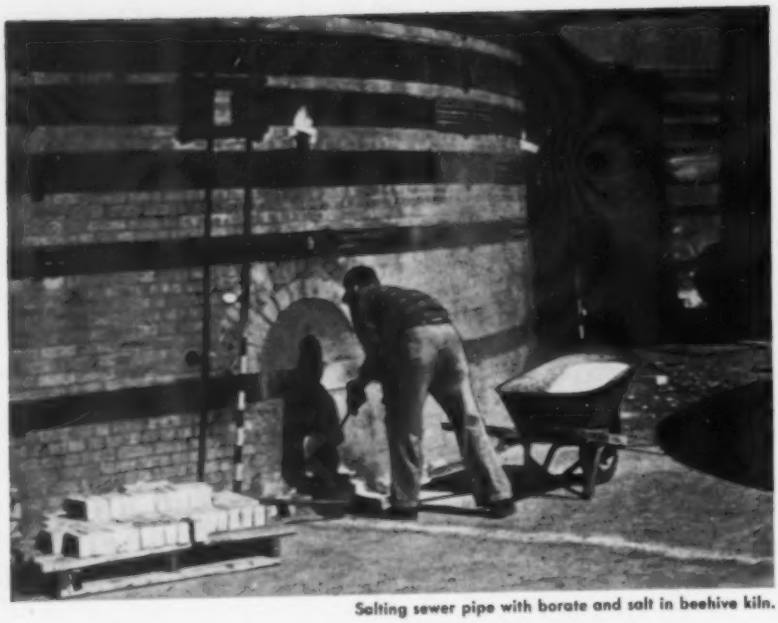
Names of satisfied users furnished on request

$4000.00
F.O.B. FRANKFORT, INDIANA

No other comparable machine in the field today will match the productivity and dollar profit that PITCHMASTER affords to make it a common sense investment.

E & R MFG. CO. INC.
FRANKFORT, INDIANA

Circle Service No. 35



Salting sewer pipe with borate and salt in beehive kiln.

Salters! get a better glaze...

add **RASORITE® 46**
sodium borate concentrates

...a thrifty form of borax for you!

When used for salt glazing, RASORITE 46 is a real performer! This low-cost borate ore concentrate equals higher priced borax and boric acid in its salt-glazing action. You get their benefits at a discount. So, add RASORITE 46 to your salting to improve the quality of your ware... to save on fuel costs... to get increased production with fewer rejects. Remember, a borate-salt mixture yields the best glazes for sewer pipe... and RASORITE 46 gives you the most B_2O_3 for your money!

Write for further information today!

U.S. BORAX

630 Shatto Place, Los Angeles 5, California

Distributors Conveniently Located in All Principal Cities

Circle Service No. 42

Glen-Gery . . .

(Continued from page 66)

Flashing of the brick is done at the last two burners in the fire zone of the kiln, also with producer gas. The gases resulting from the flashing process are not allowed to travel the length of the kiln as in many processes, but rather they are exhausted through a special exhaust fan located just past the relief ports at the discharge end of the fire zone. A flue located between the flashing burners runs under the hearth of the kiln and up the sidewalls of the kiln connecting to the exhaust fan.

Cooling Zone Features

The 112-ft. 2-in. cooling zone of the kiln also contains some special features which Glen-Gery personnel wanted to have in this new installation. In addition to the air supply fan on the cooling zone, there are two high temperature Garden City fans to provide recirculation of cooling air in this zone of the kiln. The recirculation of air in this zone also serves to cut down differential from top to bottom of kiln. A fourth fan on top of the kiln provides under-car cooling in the closed-bottom kiln. This under-car cooling air, after being introduced into the bottom of the kiln, is discharged through the kiln exhaust fan through the sidewalls of the kiln and into a plenum.

Waste heat for use in the dryers is obtained from three sources in the cooling zone. First it is obtained from the top of the crown of the cooling zone, secondly, from the relief ports and thirdly, from the top of the crown in the furnace zone of the kiln. The temperature of the waste heat is controlled by blast gates in the waste heat duct at these three points and also by both internal and external openings in the relief ports.

A lot of preliminary designing went into this particular installation at the Reading plant, all based on Glen-Gery's experience with the operation of all the other tunnel kilns which this company operates. That this experience payed off in the design of the kiln was proved when the very first car of brick discharged from the new kiln was all of No. 1 grade and it was shipped immediately to a customer.

NADD New Member

Pittsburgh Brick and Tile Co., Pittsburgh, Pa., recently became the newest member of the National Association of Distributors & Dealers of Structural Clay Products, the only distributor-dealer organization within the clay products industry.

Answers to questions concerning the benefits of NADD membership are always available by writing Barney Haines, membership chairman, P.O. Box 3585, Washington 7, D. C.

Named Research Director

W. Roderick Bliss has been named assistant director of research, Selas Corp. of America, Dresher, Pa., according to a recent announcement. Mr. Bliss comes to Selas from the Martin Co., Baltimore, Md., where he held the position of manager, industrial development, on the corporate planning staff. Previously, he was manager of the firm's electronic technical staff in Denver, Colo.

Statement Required by the Act of August 24, 1912 as Amended by the Acts of March 3, 1933, and July 2, 1946 (Title 39, United States Code, Section 233) Showing the Ownership, Management and Circulation Of BRICK & CLAY RECORD published monthly at Chicago, Illinois for October 1, 1961.

1. The names and addresses of the publisher, editor, managing editor, and business managers are:

Names	Address
Publisher, J. J. Svec	Westchester, Illinois
Editor, J. J. Svec	Westchester, Illinois
Managing Editor, Neal F. Mohler	Park Forest, Illinois
Business Manager, Floyd M. Burdick	Elmhurst, Illinois

2. The owners are: Industrial Publications, Inc., Chicago, Illinois; a subsidiary of Cahners Publishing Co., Inc., Boston, Massachusetts; Maurice P. Driscoll, Oak Park, Illinois; Fred L. Steinhoff, Chicago, Illinois; John H. Van Deventer, Chicago, Illinois; John W. Parshall, Winnetka, Illinois; James M. Lange, Lincolnshire, Illinois; J. J. Svec, Westchester, Illinois; Frank J. Amstadter, Chicago, Illinois.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state) . . . None.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than a bona fide owner.

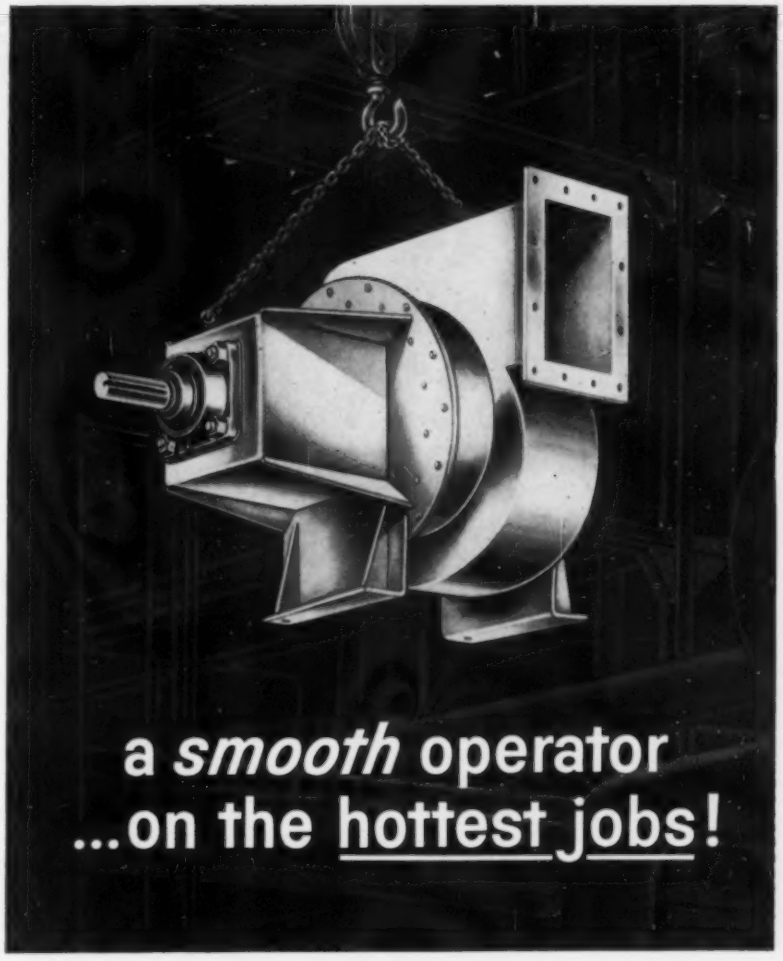
5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was 4373.

J. J. Svec,
Editor & Publisher.

Sworn to and subscribed before me this 20th day of September, 1961.

Karl H. Clarke,
(Seal) Notary Public.

(My commission expires November 28, 1964)



Of course, not every industrial process requires fans that will operate in temperatures up to 2000° F. But when they do . . .

. . . *no job is too hot to handle for a Thermal-Aire Fan!* High temperatures, corrosive atmospheres, dust-laden or gaseous environments . . . whatever the condition, you can rely on Thermal-Aire Fans for smooth, dependable performance because . . .

. . . *every Thermal-Aire component is designed for the job!* A good example is Garden City's exclusive Air-Cooled Shaft. Without water cooling, heat slingers or other cooling systems, this unit disperses heat quickly, efficiently. Keeps bearings cool. Prolongs fan life. The Air-Cooled Shaft is typical of the engineering skill and manufacturing quality built into Garden City Fans for more than 80 years.

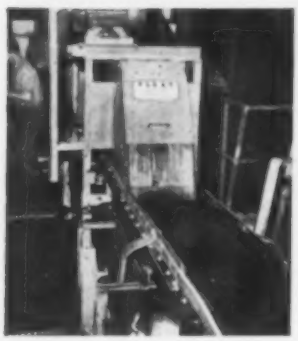
For a smooth operator on *your* hot jobs, be sure you specify Thermal-Aire Fans! Write today for Bulletin 960. *Garden City Fan & Blower Co., 807 North Eighth Street, Niles, Michigan.*

Thermal·aire Fans®

Circle Service No. 41

YOU CAN'T TELL THEM APART...

when PEKAY BLENDERS add



UNIFORM COLOR CONTROL to every brick run

Simple proportioning of raw materials isn't enough to insure uniform brick color throughout your run. Materials must be *thoroughly blended and mixed* before you can be sure you're getting the exact color match your customers demand.

Pekay Blenders assure color uniformity—in any size run—by completely mixing all raw materials *right on your existing conveyor system.*

Rapidly revolving blending wheels pick up all proportioned raw materials in small increments and thoroughly mix them into a uniform mass ready for moisture addition. This operation is continuous as long as materials are moving along the conveyor, and can be tied into any manually or automatically controlled conveyor system.

Low-cost Pekay Blenders quickly pay for themselves by avoiding waste, eliminating expensive and time-consuming hand sorting, and cutting operating costs. They require no expensive changes in your existing facilities, are installed in a few hours, and are ruggedly built to withstand the hardest service with a minimum of attention.

Be sure you — and your customers — can't tell the difference between one brick and the next. Get full information on Pekay Blenders. Fill in and mail the coupon — now!

PEKAY
MACHINE & ENGINEERING CO., INC.

2510 W. Lake Street, Chicago 12, Illinois

Please send me details on these money-saving Pekay products.

☐ Pekay Blenders ☐ Pekay M-T-Matic Buckets

Name_____

Company_____

Address_____

City_____ Zone____ State_____

Circle Service No. 36

Reliability...
ORTON CONES

Any measuring device must be accurate with known standards, and that's what can be said for Orton Standard Pyrometric Cones.

Not only are the cones themselves uniform in performance day after day and year after year, but you can rely on the Orton Foundation to supply a cone that specifically fills your need . . . regardless of the temperature range in which you work.

Orton Cones can also be relied upon for checking the accuracy of ordinary measuring devices. If you are not fully utilizing this economical, efficient and reliable method of firing control, investigate the potential of Orton Cones at once, for you'll find the proper use of cones will point the way to better firing and more uniform ware.

Request the newly revised edition of "The Properties and Uses of Pyrometric Cones."

Foreign Sales: **International Division, The Ferro Corporation, 4150 E. 56th St., Cleveland, Ohio, or the Foundation**

the firing insurance of thousands

The Edward ORTON Jr. Ceramic FOUNDATION

1445 Summit St., Columbus 1, Ohio, AXminster 9-8023

Circle Service No. 37

Ceramic Block . . .

(*Continued from page 62*)

of the material previously discussed.

Summation. It now has been shown that it is possible to expand partically within a ceramic block during firing both the refractory and bonding phase, e.g., pyrophyllite and expansible shale particles. In the case where expansible shale particles are used, some lightweight aggregate is actually manufactured in the ware during the firing of the body. The only way one can tell for certain the difference between a ceramic block that used previously expanded shale as its bonding agent and one that employed unexpanded, expansible shale as the bonding phase, is by weighing the two differently compounded blocks. Could you definitely determine between Figure 1 and 2 which contained the cheaper ($1.50/ton) expansible shale? Well, Figure 2 is the one. Figure 1 contained as the bonding phase aggregate a previously expanded shale. These two intragranular cross sections visually point out the fact that it is hard to tell the weight of a porous ceramic block body by the visual estimation of the amount of bloating within the individual particles.

Problems Can Be Solved

By the use of conventional or slightly modified concrete block machinery as the forming apparatus for a ceramic article, many problems that are not common to current brickyard practices are encountered. However, these problems can be solved by the application of engineering effort. If along with this effort, a bit of imagination is applied, then innovations and techniques, currently foreign to the structural clay and refractories industry, may become common place and eventually profitable. The latter is by far the most interesting!

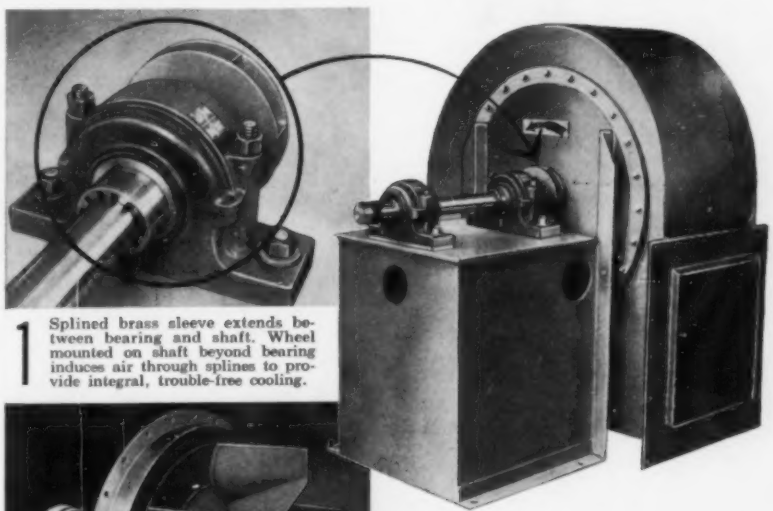
Appointed Sales Manager

George Puddington has accepted the position of sales manager for the Delta Brick & Tile Co., Inc., Indianola, Miss., in connection with the distribution of their products made both at their new white burning plant at Macon, Mississippi and their buff burning plant at Indianola.

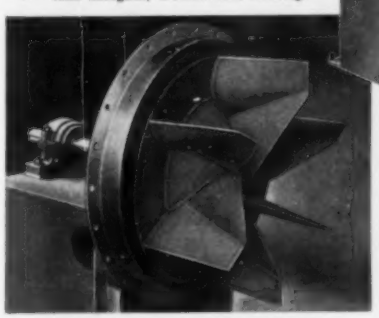
3 *outstanding features make this*

ROBINSON EXHAUSTER

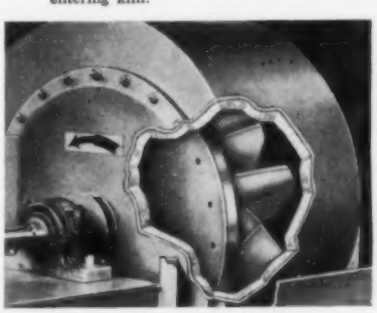
BEST for recirculating hot air in kilns—up to 1650°F.



1 Splined brass sleeve extends between bearing and shaft. Wheel mounted on shaft beyond bearing induces air through splines to provide integral, trouble-free cooling.



2 Cartridge type wheel assembly is removed from the drive side of the exhauster. Inspection and maintenance of both wheel and exhauster is simplified and speeded, without entering kiln.



3 Steel outer skin and alloy inner casing are separated by high-temperature insulating material, minimizing heat loss in kiln air, and reducing heat radiation and conduction to other parts.

Three unusual features—exclusive integral self-cooling, cartridge-type wheel assembly, and carefully engineered use of insulation and alloys—help Robinson High-Temperature Exhausters give unsurpassed efficiencies in recirculating hot air in kilns. These important features are the results of Robinson's long experience in improving air handling procedures in the ceramic industry's high temperature operations.

Because a successful kiln or dryer design depends heavily on proper air handling, Robinson engineers will work in a consulting capacity with your designers and builders. It is added assurance that you will get the most economical and efficient firing and drying facilities.

If you are building new facilities, or refurbishing existing ones, specify Robinson—for superior air handling matched to proper kiln and dryer design.
Write today for literature.

INDUSTRIAL FANS • BLOWERS • EXHAUSTERS

ROBINSON VENTILATING CO.

119 HENDERSON STREET, ZELIENOPLE, PA.

Circle Service No. 38

no more downtime to replace connectors...

HANCO FLUX POWER SCREEN HEATERS

transmit power through the air!

With the all new Flux Power by Hanco all mechanical connections between transformer and screen are eliminated. The 0 to 4000 ampere current is transmitted through the air by inserting a conductor through the eye of the transformer. This permits unrestricted vibration, maximum power transmission and true screen balance.

5 YEAR GUARANTEE

★ Dust-tight, waterproof construction
★ Dual voltage, 220/440 volt
★ Use either plain or stainless cloth
★ Anti-magnetic steel side rails

write today for full details:

HANCO INTERNATIONAL

CANTON 7, OHIO, U. S. A. — CABLE HANCO

EUROPEAN SALES AND MFG.
HANCO INTERNATIONAL
6 WIBAUTSTRAAT • AMSTERDAM, HOLLAND

Circle Service No. 43

Announce Stock Split

The board of directors of R. G. Varner Steel Products, Inc. of Pine Bluff, Arkansas, announced a five for one split of the firm's common stock.

Varner Steel manufacturers and distributes a complete line of pre-engineered uniframe buildings under the trade name Varco.

R. G. Varner, president of the firm, also announced that Varco had made after-tax earnings of eighty-eight cents per share of stock during the first four months of the current fiscal year. The earnings figure was based on shares of stock prior to the split.

Case Sales Rise

Optimism was the keynote of a 3-day marketing sales meeting held by J. I. Case Co., as department heads from the U. S. and Canada gathered at the firm's Racine, Wis. offices to plan 1962 strategy. Case manufactures a full line of farm tractors and machinery as well as industrial tractors and equipment.

With sales at retail for August and September up sharply over the same

(*Continued on page* 86)

- **Fluorspar**
- **Magnetite**
- **Chromite**
- **Manganese**

NATIONAL PAINT & MANGANESE COMPANY offers the following advantages:

1) Two producing plants strategically located at Brownsville, Texas and Lynchburg, Va. Complete inventories are constantly maintained at plants and Lindale, Texas warehouse.
2) Technical representatives backed by modern research facilities coupled with 66 years of experience present a backlog of unparalled information that is available to the brick producing industry.
3) Comprehensive quality control beginning with ore source and continuing throughout processing has been established to assure uniform product to customer's specification.

Serving the building brick industry is our business—not a sideline.

NATIONAL "ALWAYS UNIFORM" ESTABLISHED 1894

NATIONAL PAINT & MANGANESE COMPANY

A division of Howe Sound Co., Inc.

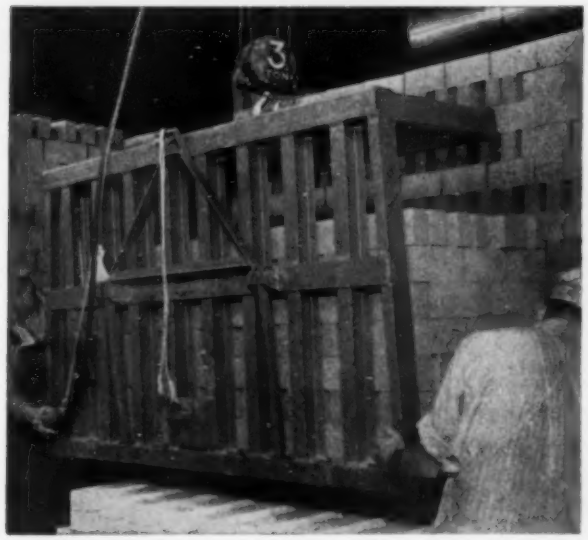
810 Park Building
Pittsburgh 22, Pa.

Plants:
Brownsville, Tex.
Lynchburg, Va.
Warehouse:
Lindale, Tex.

CONTRIBUTING ASSOCIATE SCPI

Circle Service No. 45

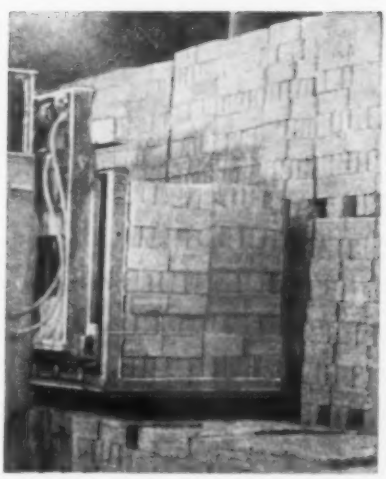
Make Brick Handling Easy...



PRIESTER Brick Forks

- Save Time
- Save Money
- Save Labor

Also Priester truck cranes for unloading from delivery trucks. Write for bulletin.



Brick in units of any size are handled by Priester Brick Forks. Automatic operation simplifies and speeds brick handling, setting and drawing kilns, loading and unloading trucks and box cars.

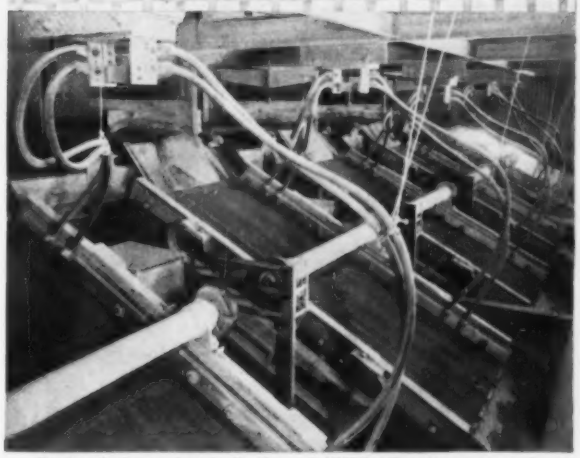
Forks with flap grippers for cored and solid brick. Give service . . . take the hard work out of brick handling. Write today for more information.

BRADNEY MACHINE CO., INC.

Middletown, New York

Circle Service No. 47

this screen stays clean!



Each of these electrically heated "UP" vibrating screens is connected to a 12-kva transformer.

ELECTRICALLY HEATED CLOTH PREVENTS BLINDING OF LINK-BELT "UP" VIBRATING SCREENS

Link-Belt "UP" vibrating screens always work at *full capacity!* Even the "stickiest" jobs can't dampen their efficiency. Electrically heated screen cloth combines with high-speed elliptical vibrating action to maintain high-volume, precise, blind-free sizing.

"UP" screen cloths are heated by a "series" arrangement. Few cables are needed and initial cost is low. The "series" method (originated by Link-Belt) provides extremely uniform heating with a very low current consumption. Other "UP" economy features include overall rugged construction and two-bearing design simplicity.

Available in open and enclosed types, single or double decks, in a wide range of sizes. For full details, ask your nearest Link-Belt office for Book 2777.

LINK-BELT

15,020

VIBRATING SCREENS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Warehouses, District Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs; Switzerland, Geneva. Representatives Throughout the World.

Circle Service No. 48

months a year ago, and October prospects pointing in the same direction, Case was looking to last quarter sales that would top the corresponding period of last year by "several million dollars".

New Castable Liner

The Oak Hill Foundry & Machine Inc., Oak Hill, Ohio is producing a castable liner for mold boxes. This product is designated as the Oak Hill Liner, and is a Ni-Hard base with controlled percentages of nickel and chromium.

This Ni-Hard liner was first used in 1957. Many improvements have been made in the metal and molding. Plate for side liners have been cast 18" long and finished to ¼" thick. Due to the modulus of elasticity and damping qualities of this material, it does not warp or bend in the box when press is in operation.

Other features of the Oak Hill Liner is the high polish attained on the surface grinder. The wear resistance of the liner is possible due to the carbides on the surface of the metal. These carbides eliminate scoring from top to bottom of mold box.

Must Develop Manpower In Depressed Areas

The future economic growth of depressed areas in West Virginia, Virginia and Pennsylvania will greatly depend on developing the manpower resources in low employment communities, stated Douglas Whitlock, Chairman of the Board of the Structural Clay Products Institute.

The brick industry leader indicated that these depressed areas which have been bypassed by industrial development must lift themselves up by their bootstraps. He stated that programs are being created to stimulate economic growth of these communities.

Joins Research Staff

Roland R. Van Der Beck joined the staff of the Foote Mineral Co., West Chester, Pa., as manager of ceramic research. He had been with the refractories division of the Carborundum Co., where he was assistant manager of the technical branch.

As Foote's manager of ceramic research, Dr. Van Der Beck will direct investigations concerned with the use and beneficial effects of lithium compounds and minerals in glass, whiteware, and other types of ceramics.

'62 Annual Meeting

January 12 and 13, 1962 have been chosen for the annual meeting of the Expanded Clay & Shale Association which will be held at the Deauville Hotel, in Miami Beach, Florida.

Brick Fallout Shelters

A booklet recently published by the SCPI entitled "Clay Masonry Family Fallout Shelters", shows construction details for five types of family fallout shelters which can be built of structural clay products.

Requests for shelter information is a reflection of the average citizen's concern over protection for his family against fallout. For example, August requests from both consumers and builders increased ten times over July. In the first half of September, requests poured in at twenty-five times the July rate.

Copies of the booklet can be obtained free by writing to Fallout Shelters, Structural Clay Products Institute, 1520 18th St., N. W., Washington 6, D. C.

Jiffy-Lift
Carries its Load...
More Ways Than One

Workwise • The JIFFY-LIFT four-cable suspension eliminates swinging while carrying 10,000 pounds with ease. Dual controls let the operator load or unload from either side. An efficient four-wheel drive eliminates slipping, gives faster, smoother operation, and makes unloading on an incline much safer.

Economywise • The JIFFY-LIFT is engineered for fast, easy installation, long service with minimum maintenance, and needs only one operator for any operation. You can *triple deliveries* with a JIFFY-LIFT, and save money as you save time.

Elberfeld Manufacturing Company also makes the versatile BOOM LIFT for those of you who have need of the features offered only in a "boom type" lift. Get full information on both these quality lifts. Phone, wire or write:

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Manufacturing Co., Inc.
Elberfeld, Indiana, U.S.A. • Telephone 131

JIFFY LIFT

Circle Service No. 46

Report Brick Production

One out of every six brick manufactured this year in the United States is a product of Carolina and Virgina kilns.

The *Wachovia*, a magazine published by the Wachovia Bank and Trust Co., Winston-Salem, N.C. reported in a current issue that the three states comprise the nation's number one brick producing region, manufacturing approximately 1.2 billion brick each year.

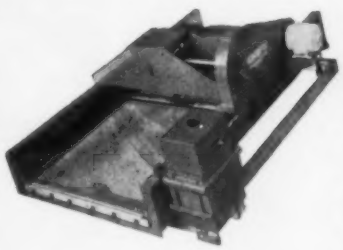
New Canadian Subsidiary

N. P. Pitt, president of Canadian Refractories Ltd., Montreal, P. Q., recently announced that Clayburn-Harbison Ltd., of Vancouver, B. C., is now a subsidiary company.

R. M. Hungerford, formerly vice-president of Evans, Coleman and Evans Ltd., becomes president of this subsidiary.

Clayburn-Harbison Ltd. manufacture and market refractories, clay face brick and vitrified clay pipe in British Columbia, Alberta, Saskatchewan and the Pacific Northwest of the U.S.

Complete Integration Steps Up Screening Efficiency



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The result is dry, wide open mesh on long, tedious schedules . . . without service stops. Send for Bulletin 16-EH.

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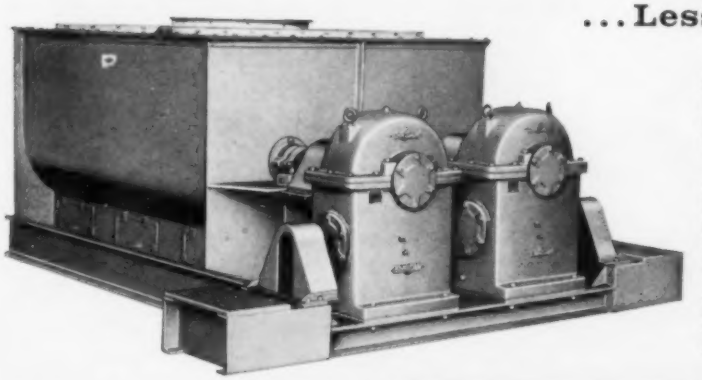
EHRSAM® **DOUBLE-BARREL MIXER**

Increases Productivity ...Lessens Costly Downtime



The Ehrsam double-barrel paddle mixer writes its own ticket for economy and increased productivity as a fast, heavy-duty machine for the intensive blending of dry, powdered or granular materials.

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EHRSAM Enterprise, Kansas

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FIRM_____

ADDRESS_____

TOWN_____ STATE_____

E-M/2-661

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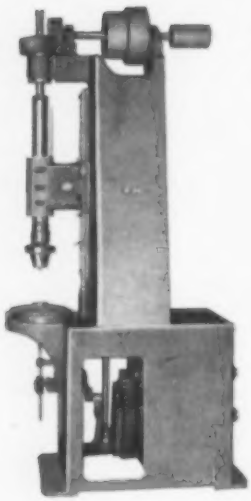
FROM COAST to COAST

BAIRD



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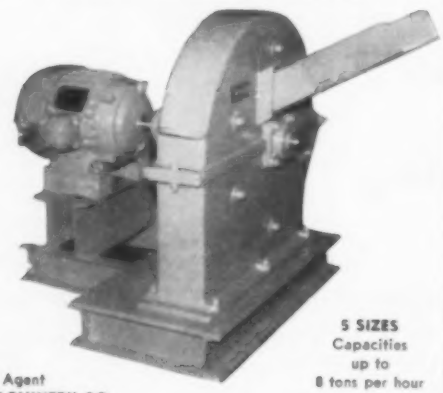

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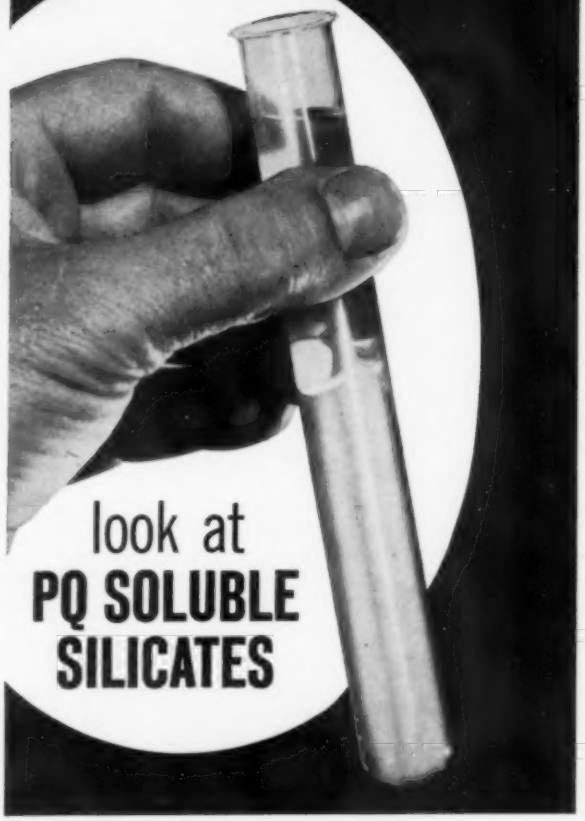
Circle Service No. 39

working on a new process?



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Refractories . . .

(*Continued from page* 70)

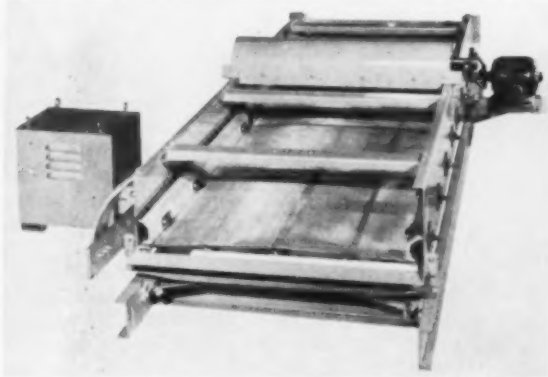
amount of each phase is governed by the composition. The average grain size varies with temperature and with time at temperature. The shape of the grains results from a balance by the grain growth and boundary energies. The distribtuion of phases depends upon the phase boundary energies. He concluded that the properties of refractories may be correlated with their microstructures.

Charles McFadden, Bickley Furnaces, Inc., Philadelphia, discussed the design features and availability of fuel fired furnaces and kilns for laboratory as well as production use in his paper, "Firing Refractory Specialties at Temperatures to 4000°F." The equipment designs discussed included top, bottom and front door loading designs—firing systems include gas-air, oxygas and electric nonmetallic elements. Production kilns with pebble bed regenerators and alloy tube recuperators with capabilities to 110 tons per burn at 3300°F were also discussed.

The symposium on Pouring Pit Refractories was opened on the second day of the sessions by G. H. Anthony, Youngstown Sheet and Tube Co., Youngstown, O., with his paper, "Pouring Pit Refractories—Present Status And Improvements for the Future." Present day pouring of pit refractories and their use in steel plants were discussed in general terms. Typical physical property data were presented for the various classes of ladle brick, stopper rod sleeves, nozzles and stopper heads. Common defects of these products are related to service performance.

"An Investigation of Nozzle Design for Steel Pouring in Continuous Casting," was the title of the paper presented by Rufus Easton, Koppers Co., Pittsburgh. Factors involved in the design of the nozzles used for pouring steel were discussed. A program of design investigation was described in which flow patterns for the various nozzle designs were established and evaluated by use of a model. The program was followed through the various stages of birth, development, engineering, test work, reporting and translation into commercial use.

Eugene Monroe, SUNY College of Ceramics, Alfred, N. Y., then presented his paper on "Mineralogical Reactions Between Fireclay Ladle Brick and Basic Slags." In order to determine the brick composition which could best withstand slag attack, 11 different fireclay ladle brick were reacted with three basic slags at 1050°C for 90 minutes. The mineralogical changes were observed by X-ray diffraction and a comparison of the reaction products was made among the various brick. Anorthite was developed in all the brick-slag combinations. In addition, melilite was crystallized when a slag with a high CaO and Al_2O_3 content was used. A correlation was found between the amount of anorthite formed and the composition of the brick. With an increase in the amount of compositional factors, mullite, Al_2O_3, or the original kaolinite content of the brick, there was a corresponding increase in the amount of anorthite developed. The rate at which a brick deteriorates may be more rapid for brick which have a high content of any of these three compositional parameters.



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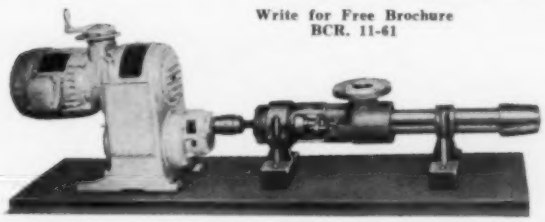

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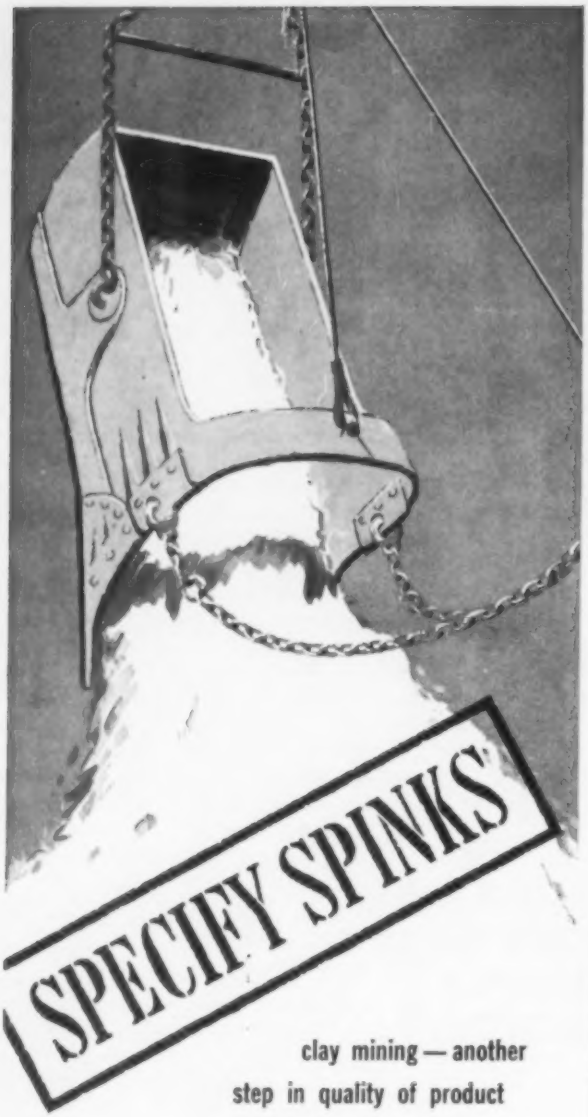

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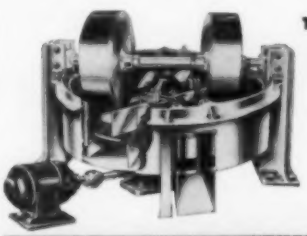

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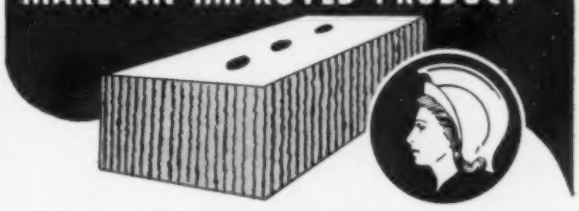
5 South Wabash Ave., Chicago 3, Ill.

STOP GREEN SCUM PERMANENTLY MAKE AN IMPROVED PRODUCT



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We desire to employ as service engineers, men with tunnel kiln operating experience. This is field work with principal duties consisting of starting-up operations, trouble-shooting, and servicing. Must be free to travel with main office in the Pittsburgh area. Degree not required but experience is essential. Submit in confidence your resume of education and experience to:

Swindell-Dressler Corporation
Personnel Dept.
P. O. Box 1889, Pittsburgh 30, Penna.

CAREER OPPORTUNITIES—Research and development, quality control, production methods and management opportunities are available with Southwest's leading clay products manufacturer. Ceramic Engineering Degree required with salarey commensurate with experience. Send resume, stating salary requirements to: Acme Brick Company, Box 425, Fort Worth, Texas. Attention: M. L. Vaughan.

WANTED—Plant Superintendent with experience and good references for brick plant with stiff-mud machinery and tunnel kiln in New York State. Salary open. Please give full details in first letter. Write Box 10-BDD, care of Brick & Clay Record.

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CERAMIC ENGINEER—Desires challenging plant position. Experienced in both tunnel and shuttle kiln design, construction, operation, and handling problems of both brick and whiteware plants. Also some experience in refractory research and development. Write Box 11-BBR, care of Brick & Clay Record.

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WANTED

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1—Marcy #64-1/2 ball mill, 100 HP.
2—8'-6" x 70' rot. dryers, ⅝" welded.
1—6' x 150' rot. kiln, ⅝" welded.
1—Bonnot 5' x 10' contin. ball mill, 75 HP.
1—Symons 2' shorthead cone crusher.
1—Allis-Chalmers 6' x 12' rod mill, 125 HP.

IN STOCK

1—Vulcan 10' x 11' x 175' rotary kiln.
3—10' x 100' rot. dryers, ⅝" shell.
2—National 10' x 78' rotary dryers, ¾".
2—8'-6" x 70' dryers, ⅝" welded.
1—Traylor 8' x 80' rot. kiln, ⅝" welded.
1—Allis-Chalmers 7' x 120' rot. kiln, ⅝" welded.
2—Bonnot 7' x 110' rot. kilns, ⅝" shell.
1—6' x 7' x 100' rot. kiln, ⅝" shell.
1—Standard 3' x 23' rot. dryer, ¼".
1—Raymond 66", 6-roller hi-side mill.
1—Raymond 50", 5-roller hi-side mill.
1—Hardinge 8' x 48" conical pebble mill.
2—Hardinge 7' x 36" conical pebble mills.
3—Allis-Chalmers 5' x 22' ball-tube mills.
6—Jaw crushers: 36" x 15", 24" x 12", 20" x 6", 18" x 9", etc.

PERRY EQUIPMENT CORP.
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POplar 3-3505

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1—MAXIMULLER No 1, 10' Diam. Late model, Timken bearings throughout, V Belt drive with motor.
1—HUMMER SCREEN, 4' x 10' Type 38, Electrical heated. Late model complete.
1—BRICK MACHINE—1-Steele 50 Model C, separate motor drives with motors.
1—STEELE 18 Special cutter, off bearing belt. 2⅝" cut.
2—BELT FEEDERS To Maximuller & Brick Machine. With variable speed reducer drives.
1—9' DRY PAN—Stevenson with extra parts.
1—7' R'M DISCHARGE grinder with motor.
1—TURBO BLOWER National No. 324, 15 HP Motor.
2—OIL TANKS 20,000 gal each. Heater coils, including 40 HP Package boiler, with motorized pumps.

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DEAIRING BRICK MACHINES—3 sizes
PUG MILLS—8', 10'—Single & Double Shaft
GRANULATORS—Chambers #51 Freese P-16
CUTTERS—Chambers, Steele #18 & Hand
DRY PANS—7' & 9'
HAMMER MILLS—Many Sizes
SMOOTH ROLLS—12", 18" & 24"
CONICAL ROLLS—Chambers & Brewer
DISINTEGRATORS—12", 16", 24"
JAW CRUSHERS—Many sizes
GYRATORY CRUSHERS—Allis Chalmers #5

50/100 t.p.h. CRUSHING PLANT
w/Conveyor, Screen, Bag House

FEEDERS—5' Disc, Apron, Reciprocating
ROTARY DRYERS—24" to 8' Diam.
DRY MIXERS, Lancaster SKG, #3, #4, Simpson #3 Clearfield #610
SIGMA BLADE & RIBBON MIXERS—Several
SCREENS—Many—Single & Double Deck
HARDINGE CONICAL MILLS—4½', 6', 8'
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Phone Hillcrest 2-0061

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DE-AIRING MACHINES—FRH (PA4) 3HP—FRH (PR6) 7½HP—J. C. Steele 50 Special, 15" auger 100 HP—Bonnot 18" auger 150 HP—American (901) 18" auger 200 HP

CUTTERS—Automatic Reel—J. C. Steele #18—Freese P25, 10" belt—Chambers #10, Roman & Norman brick

PUG MILLS—9' Freese—10' American (2nd shaft)—15' Granulators Freese/Chambers

DRY PANS—7' American—9' Bonnot—2 American 418 grinders

DRYERS—24" x 24"—3' x 24'—5' x 40'—6' x 20'—7' x 53' (50 HP gearmotor)

CRUSHERS—DISINTEGRATING—18" x 16", 24" x 12"—30 x 16—24 x 30

LAWLER COMPANY
Metuchen, N. J. Liberty 9-0245

ONE Steel Model 20-E combined auger de-airing machine and one Model 20-E.
FIVE assorted brick dies, ' hollow tile-patio die and roman brick die.
ONE, Steel No. 40-E combined de-airing machine
ONE, Real Hand cutter.
ONE, Steel No. 18 Automatic Cutter.
ONE, International De-airing Combined Falcon, with extra liners knives, pinion shaft resurfaced augers—good condition.
ONE, American Automatic No. 858 Automatic Electric Cutter good condition.
TWO Fernholtz 40" cage type ulverizers, one SK.F. bearing the other water cooled babitted bearing, all good condition.
ONE, No. 1 and No. two Paird Pot Machines with seven pot dies, all good condition.
ONE, Model W.6422 4½ x 4 twin cylinder water cooled Quincy Vacuum Pump excellent condition.
ONE, 4' x 40 ft/horizontal refractory lined dryer with stack combustion chamber 5½ hp. motor gear reduction drive Johnson oil burners, good condition.

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FOR SALE—USED EQUIPMENT

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For Sale—One used twin rotor impactor, 80 to 100 TPH capacity, in good condition, less motors.

1—Model 42-0 Lancaster AutoBrik Machine built in 1957.
1 - Lancaster Big Boy Heavy Duty Granulator built in 1952 - used only 3 months.
Miscellaneous Parts and Equipment for Soft Mud Brick Plant - Potts, Wellington, Lancaster, Chambers.
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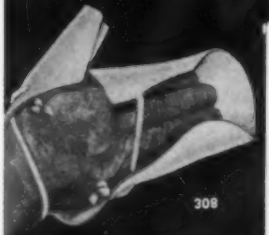

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Increase the output of your men. Protect their hands with Tufhorse hand pads, gloves or mittens. Made of heavy, durable cowhide, Tufhorse Kant Rips are flexible, tough, help men work faster.

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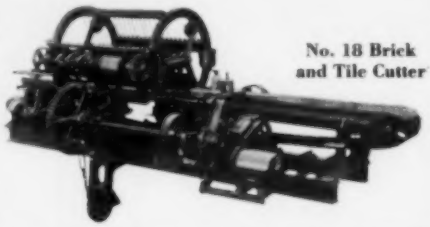


No. 18 Brick and Tile Cutter

No. 88C Feeder

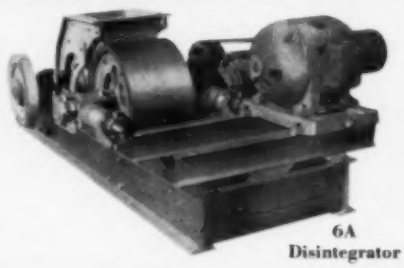
Brick and Tile Cutter

The undisputed leader in its field. Ten types of easily interchangeable cutting reels enable it to cut any type of brick or tile.

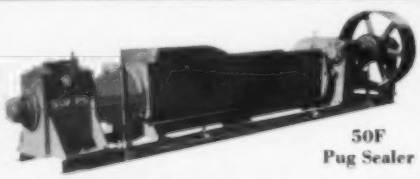
Feeders

Designed to uniformly feed many types of materials without choking, arching, or bridging. Shown here is the No. 88C. Also available is the smaller 44C model, and the larger Double-88.

Extreme ruggedness together with simplicity and accessibility are outstanding characteristics of Steele equipment. All Steele machinery is so generously constructed that overloading of any vital part is virtually impossible.



6A Disintegrator



50F Pug Sealer

Crushers and Disintegrators

Steele produces a wide variety of equipment for reducing materials of many types. Shown is the Steele 6A Disintegrator designed for reducing moist clays or for primary reduction of harder materials to a fineness of ½" or less.

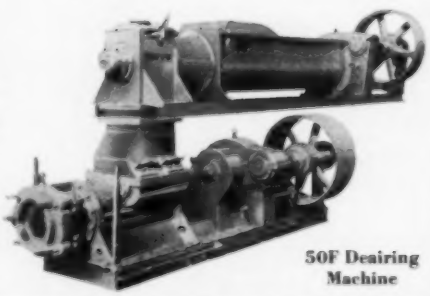
Pugmills and Pug Sealers

Eight standard Models from which to choose—from Open End Pugmills to Double Vacuum Pug Sealers. They produce finer textures, reduce lamination and greatly increase plasticity. Shown is the 50F Pug Sealer.

Pugging and Deairing Extrusion Machines

Made in six sizes, with capacities from 2,000 to over 20,000 brick/hr. Shown is the 60F, which is a separate drive machine. Three combined drive models and two other separate drive models are in regular production. The No. 50F Separate Drive is shown here. Pug Sealer can be mounted to any angle to the Extruder. All larger models can be built with vacuum pugging in addition to open pugging.

60F Separate Drive Machine



50F Deairing Machine

Write us for complete information on any equipment.

SUSTAINING ASSOCIATE

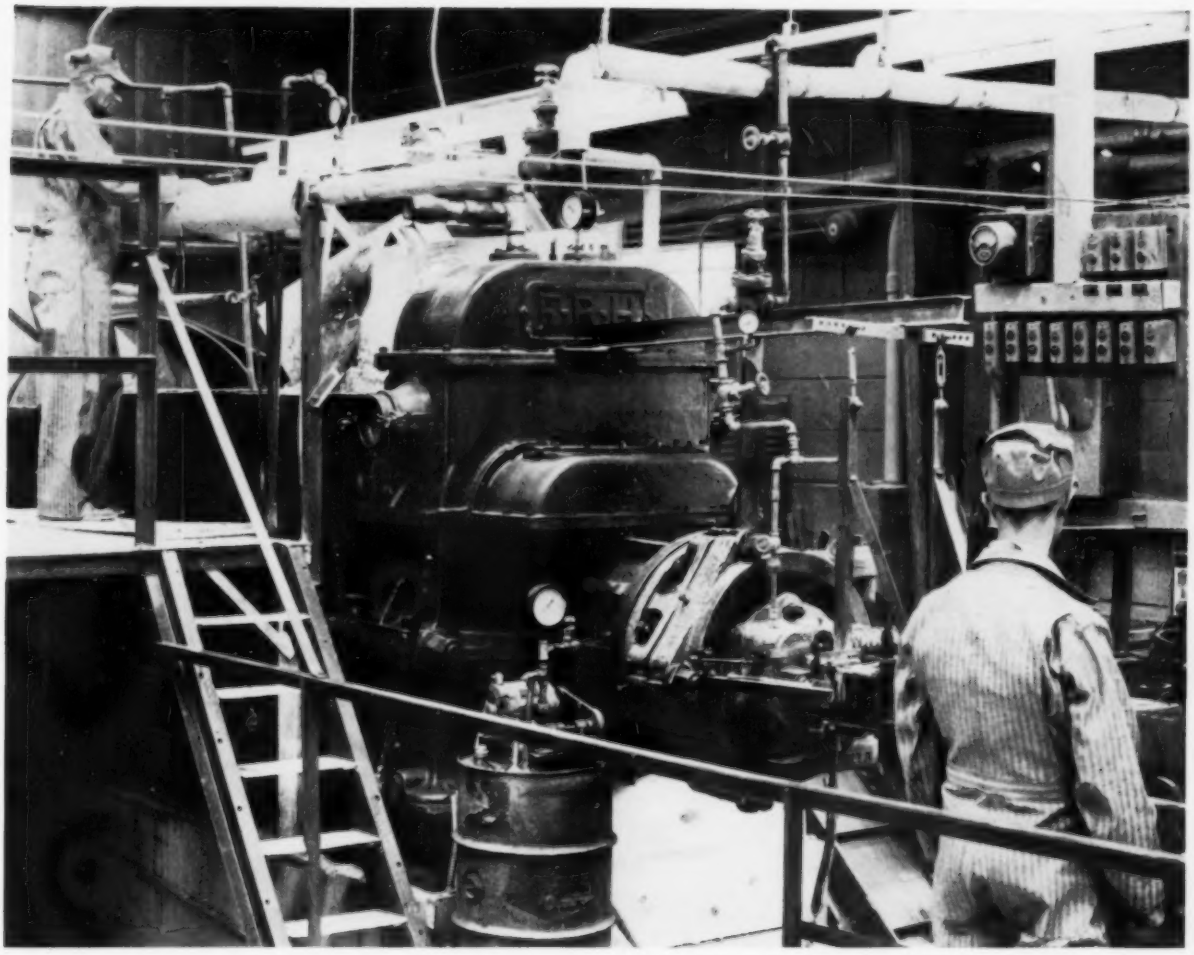
SCPI

J. C. Steele & SONS, Inc., Statesville, N. C.

Pacific Agents: Walter C. Stoll, 5028 Alhambra Ave., Los Angeles 32, Calif.

THE BEST IN CLAY MACHINERY SINCE 1889

Circle Service No. 55



"Brick Production Is Up 26%--With F-R-H De-airing Extrusion Equipment"

Reports Alliance Brick Corp., Alliance, Ohio

"Excellent," is the way Mr. Leo K. Edgar, Superintendent of Alliance Brick Corporation, Alliance, Ohio, describes the operating qualities of the F-R-H De-airing Extrusion Machine currently in use at his plant —where F-R-H equipment produces high quality face brick, turns out almost half a million units per week.

"Our brick production is up about 100,000 units for a 40-hr. work week, maintenance time is down considerably—since we began using F-R-H De-airing Extrusion equipment about 3 years ago," says Mr. Edgar. "Present product quality is much better, too!"

Find out today how F-R-H Brick and Tile Machines can increase production, improve product quality, reduce operating and maintenance costs for you. Simply send a brief outline of your operations to The Fate-Root-Heath Company, Dept. B-1, Plymouth, Ohio.

F-R-H

CERAMIC MACHINERY

For 100% Operating Efficiency

Order Genuine F-R-H Relpacement Parts Directly From Factory

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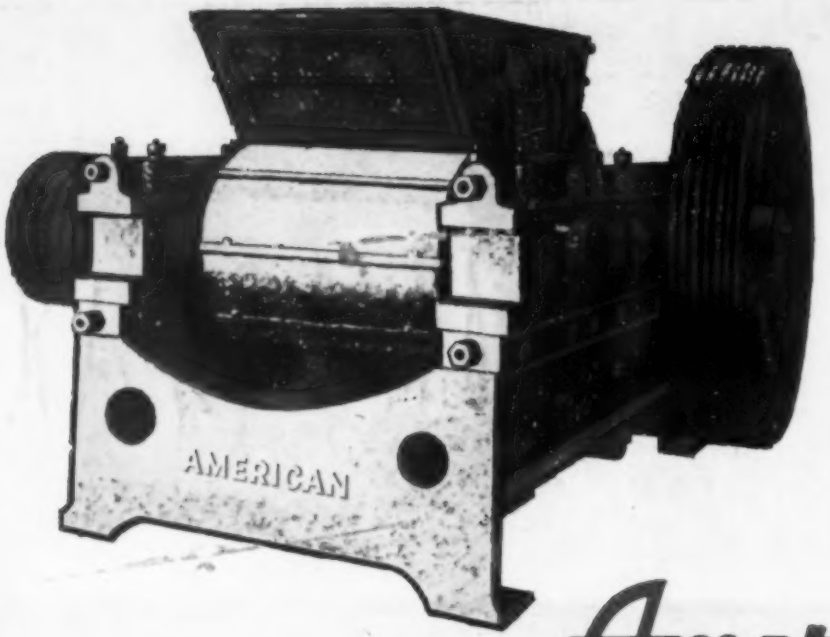
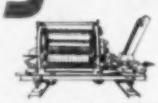


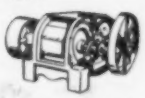
ARE PLASTIC CLAYS DECREASING YOUR PRODUCTION? Then investigate the American Disintegrators and Smooth Roll Crushers. They provide an economical solution to grinding plastic clays and soft shale. Can be used individually or in combination depending on requirements. Simple, heavy-duty construction assures years of trouble free service. Capacity of 493 Disintegrator is 30 to 50 tons per hour and the 266-A Smooth Roll Crusher has a volume of 15 to 40 tons per hour. Both types are available in models of other capacities. Get the facts soon on these and other American Clay machines—all built to increase profits.

Do Your Job The AMERICAN Way

American
CLAY MACHINERY


ELECTRIC CUTTERS

SMOOTH ROLL CRUSHERS

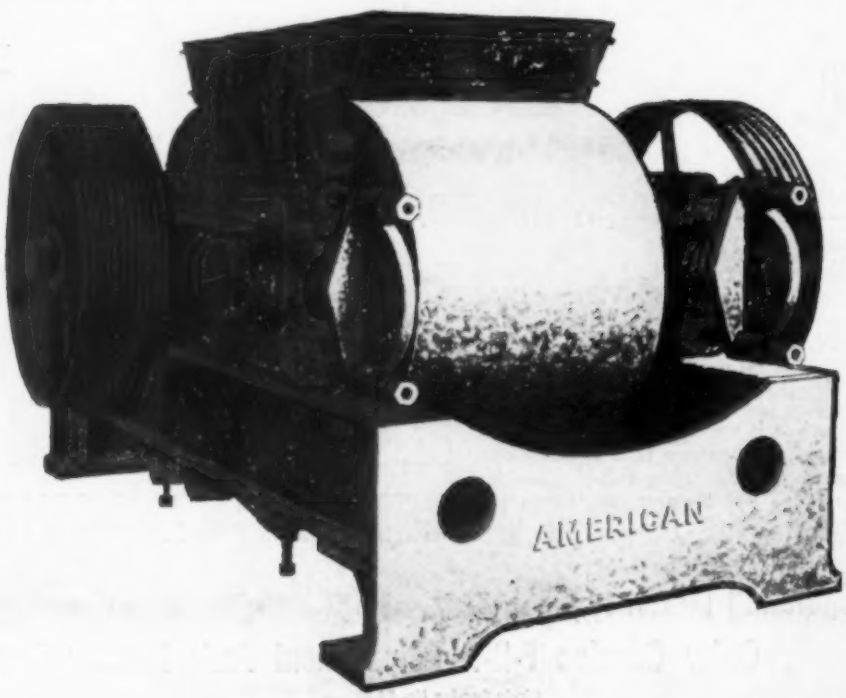

DISINTEGRATORS

PUG MILLS

GRINDERS

DE-AIRED COMBINED MACHINES

DIVISION OF
HUBER-WARCO COMPANY - Marion, Ohio, U.S.A.



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